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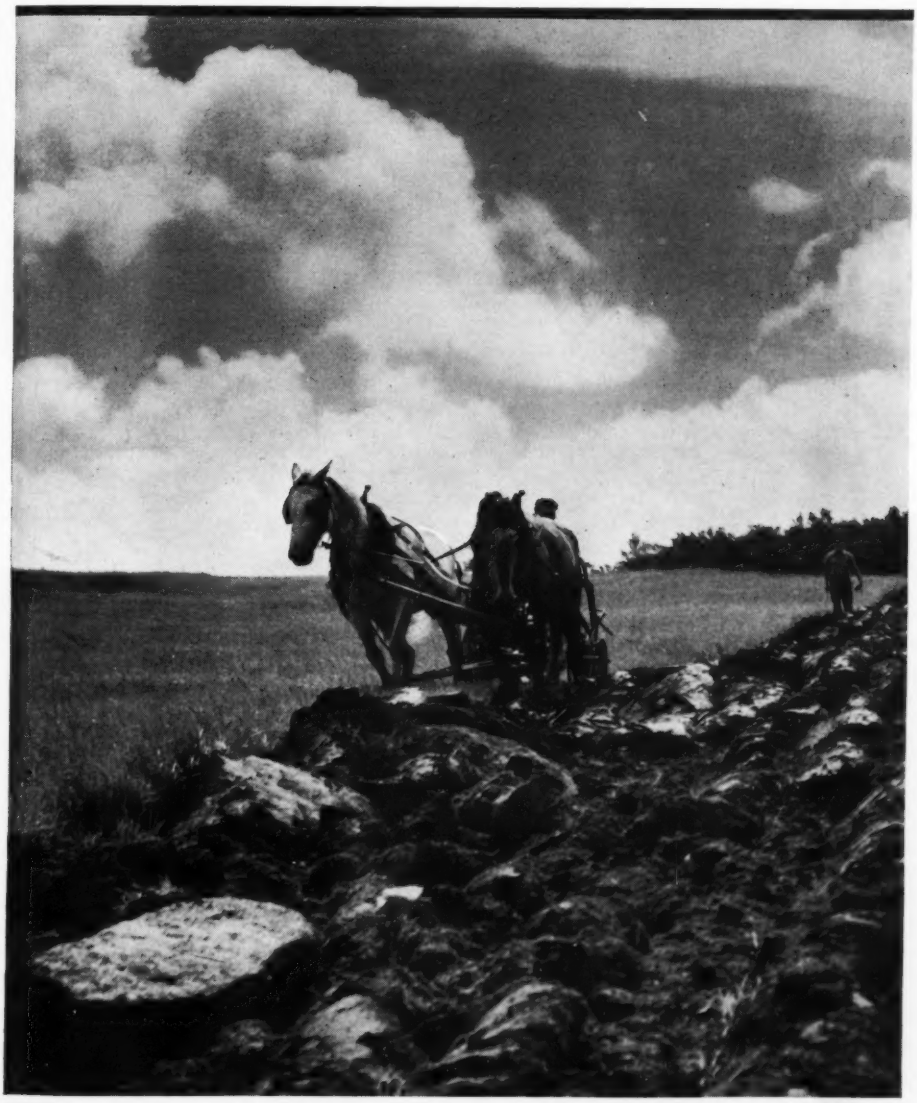

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How to Determine Fertilizer Needs of Soils

AMERICAN POTASH INSTITUTE, INC.
INVESTMENT BUILDING **WASHINGTON, D. C.**

Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

Editorial Office: Investment Bldg., Washington, D. C.

VOLUME XXV NUMBER THREE

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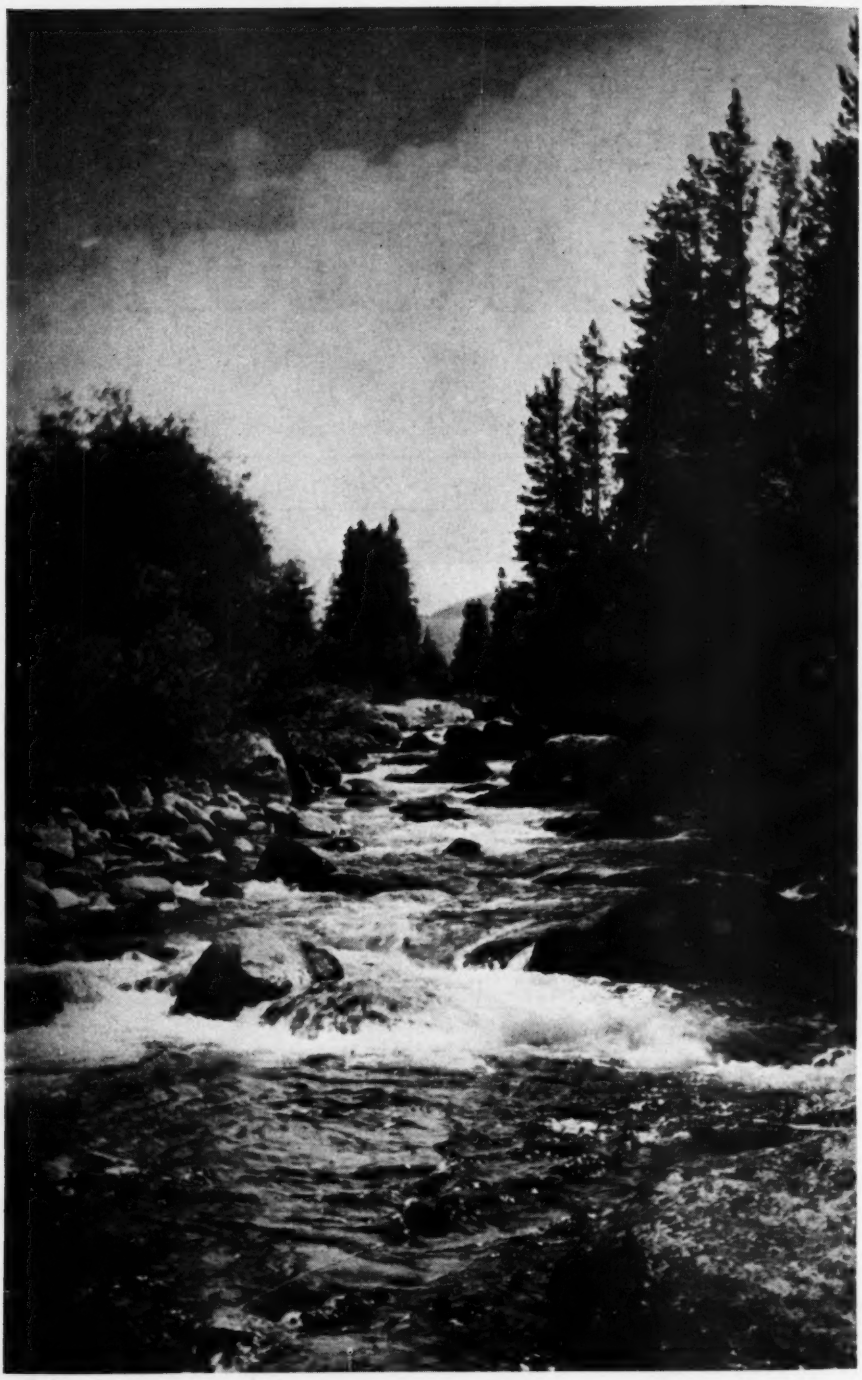

SPRING FRESHETS TRANSFORM OTHERWISE LAZY STREAMS.

Better Crops with PLANT FOOD

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VOL. XXV WASHINGTON, D. C., MARCH 1941 No. 3

Up for attention again is—

Bovinology

Jeff McDermid

"BETTER BULL" talk has been uncommonly scarce among bucolic circles of my bailiwick for nearly a decade, although it shows some signs of revival. Keen competition in that line from other professions may have forced our best rural bull authorities into eclipse. But it's more my belief that the super bovine spellbinders have been too busy since 1933 with the AAA, SCS, FSA, and FCA. At least, judging by the direction in which the best native talent of my township has been going in this "federal farming" period, we have temporarily run out of zealous bull promoters, and may have to train up a good fresh batch out of the Future Farmers.

We've got to do something drastic in bovinology if we keep on "going to grass" at the present rate of conservation. Does it sound reasonable for us to seed down so much land and push the pastures clear up to the Arctic Circle without having more and better cattle to gaze on while they graze? Until they make a breakfast food of a more satisfactory kind out of brome grass and alfalfa than hitherto, I am quite sure that our best customers for such conserving crops will run on four legs and ruminate more than we do anyhow.

Although I have tried to argue some of the dairy boys into sheep husbandry, most of them buck at such an idea. Staff or rope, nose-ring or halter, pen or no pen, it looks like we'll have to tackle the bull question all over again, and

many of us are going to be further behind than we were when we left off.

To be sure, I thought we'd said and done about all that fat tests, printers' ink, and lung power could achieve back in the days of the w. k. base period, otherwise known as the "golden age" of farming.

EVERYBODY had a chance then to learn what a little blunder in bulls would do to milk and beef ambitions. But that was before we had the modern insignia known as two-, three-, and four-star bulls—which doesn't refer, be it known, to the amount of concussion of the cranium sustained by the caretaker. It was also prior to the date when they altered the U. S. Department's annual yearbook into a costly compendium of intricate text relating to germ plasm. I presume if we had had access to chromosomes and genes and nuclei back yonder in the boom bull era we would have had less faith in fancy pedigrees and more respect for strong pasture fences.

And yet sometimes I wonder if we could have made anybody's novel array of abracadabra into an elixir powerful enough to overcome bad herd management plus bad times. It takes genius to operate those genes I surmise, and some degree of common sense directs the destiny of the chromosomes on the farm. Thus environment played its part in the frequent defeat of those better bull campaigns in the times before we had genetics brought to the farmer. I mean environment related to personal management and environment concerned with soils and economics as well; both equally affecting the extent to which the superior germ plasm survived when once planted.

The mathematics involved in a genetic calculation is a wonder to behold and always gets me dizzier than usual; but the arithmetic concerned with 10-cent corn, 15-cent butterfat, and an amortized mortgage on an inflated acreage is a far more popular indoor teaser for puzzle fans. The best ways to determine a good bull's future is to run soil tests on his home place and an I. Q. on his owner, not just a fat test on his daughters.

When I first entered the livestock arena as an observer, we used to ask ourselves the question: "When is a bull not a bull?" Answer: "When he is a gold brick."

In those plenteous days of *caveat emptor* a green ruralite did not have to walk the pavements with safety-pins on his pockets to invite predatory strangers. All he had to do was crank his car or hitch up his team and drive to the nearest county consignment sales—often known as bull bazaars. There the slickers were ready for him armed with ribbon-tied catalogs with glossy pictures of seven-day-record cows and lengthy, six-generation-bracketed pedigrees that traced a heifer's lineage clear out of sight.

THOSE catalog architects labored as dutifully and minutely over a bull's distant forebears as the Hebrew scribes when they set down the genealogy of Israel from David the king to Joseph the carpenter. Some gentleman of prodigious memory would chant the bovine family tree while the red-faced auctioneer put his larynx into high gear and set the audience coughing up legal tender or I. O. U's. Some of the notes and checks bounced back no good for groceries, but so did many of the cattle after they were boarded awhile without showing any inclination to perpetuate the pedigree.

It is not my intention to assert that everybody who horned in on the bull business was a barnyard blackguard. That would be unfair to many honest enthusiasts who were "fans royal" in the sport of cattle traffic. Besides I would have to include myself and many other hay-shaking journalists who peddled all the gilded assumptions attached to a sketchy test program and stylish family lines. On the contrary, it was a typical American way of life, borrowed from the stock market by the livestock brokers. There was no more water in our cattle than they would take to fill

well, which would be a modest way of describing those bonanza mine stocks floating like corks in the current of Wall Street and westward.

Lax and unconvincing test programs held back the dairy bull business. The sirloin gentry, like the pig pushers, depended almost wholly upon the show

ring circuit for grading their herd sires —speaking only of the corn-belt beef men—as the range boys no doubt had a system of their own. But I understand that in recent years a carcass and growth rate index is being more generally sought for the meat industry.

ANYONE who recalls the earlier cow-testing associations and the erratic and unreliable mode of conducting the private herd tests will applaud the more sensible ways of proving bulls and cows which obtains today along the milk routes.

The herd racing curse was the bane of the cooperative test groups, while the practice of selling all animals from a herd on the basis of figures for a few head tested at random is what upset the private breeder. Thousands of cattle were thus palmed off as sensations instead of sausages.

Yours truly was guilty of playing to the gallery in recording cow-testing association results. I recall fumbling around for months using what we called the "box score of the bovines," running the comparative standings of herds in a given association and for the state. We might have used our time (I won't say our talent) to better advantage by showing each herdsman how to race with himself. And it so happens that the minority who did that very same thing are the ones who survive today among our foremost breeders. Such men did not bother so much about the other guy's butterfat, but they stayed at home and jerked the weeds out of their own stables. This "contest" idea has got the best of us Yankees in many ambitious programs, and it sure put the kibosh on cow profits through misdirected aims.

Fundamentally, the finest gains came when the dairy herd improvement units hired fieldmen who knew something about crops and farm management along with their bullology. Coupling that up with soil-testing and land-feeding programs has turned attention inward toward the all-important thing of environment. Whether the mated blood lines nick or don't nick, they're not worth a nickel to a blundering booby on a barren farm.

Keeping test records for a herd-building and bull-valuing guide is another new plank being nailed into the dairy platform. I have seen herd books neatly kept and regularly reviewed for purposes of selection and progeny saving. But for every such herd book rightly used I have seen two others misused—barn sheets almost impossible to read owing to fly specks and gutter splatter, and records utterly reckless.

SUCH lads are wasting their money and the government fieldmen's time. Have we arrived at a point when dairymen must be classified and paid a bonus for neatness and progress, or does any old muckslinger still qualify for milk production in the age of vitamins? I maintain that you'll find a closer relation in the coming years between the high fat test and the low sediment test—or in other words, knowing what a herd can do and what a herd is for. If we face a deluge of animal products then, it is certain that the gropers and guessers will be strained out like specks in the milk pail.

(*Turn to page* 47)

Soil, the Substance of Things Hoped For

By Firman E. Bear

Agricultural Experiment Station, New Brunswick, New Jersey

SOIL, like faith, is the substance of things hoped for, the evidence of things not seen. Some two billion people depend upon it to supply them with food, clothing, and shelter. By and large, it never fails. But here and there carelessness in the management of the land has brought its certain reward, and those who remain to till the soil reap mostly poverty and poor health.

Yet soil is practically indestructible. It is the residue that remains after the rain, wind, heat, and frost of the centuries have done their work of tearing apart the rocks which originally covered the earth's surface. In humid areas, all but mere traces of any soluble substances which these rocks could be made to yield up have long since been washed into the sea. The insoluble part, the soil, remains as an enduring foundation on which civilizations are built, and rebuilt. Soil is the only one of our natural resources that can not be used up, that can not be destroyed.

But soil may cease to exist as a cover over the surface of the earth. It constantly seeks lower levels and, like the soluble salts that have been washed out of it, may finally find its way into the ocean. In fact, much of the soil which now covers this continent has previously been in the ocean, where it has been reconsolidated into limestone, sandstone, or shale and, centuries later, has been reelevated and remade into soil—often several times over.

Once soil is thoroughly covered with vegetation, it remains in place. For thousands of years before the Americas were discovered, the soil of this hemisphere was sewed to the earth by the roots of trees and grass. But no sooner had our early pioneers cut down the forests, and torn up the sod, than the soil started downhill. Only three centuries had elapsed when the dust storms, blowing Kansas soil out into the Atlantic Ocean, forcibly directed our attention to the fact that both wind and water are rapidly carrying our greatest natural resource away. Hurried investigation of this problem soon revealed that much of our virgin soil had already disappeared and that, over large areas, we were farming subsoil. In some cases erosion had eaten down to the useless rocks beneath.

The farmers of the United States have dug their way down into the subsoil faster than have those of any other nation that ever existed. Our engineers have invented bigger and better plows and tractors to pull them; but one of the most significant developments of recent times has been the rapidly growing realization that we plow too much. Too large a percentage of our land is being devoted to soil-destroying cultivated crops, and too little to the soil-saving sod crops.

Modern Farmers Avoid Plowing

It will be recalled that corn, tobacco, and potatoes were unknown in the Old World, and that our European ancestors had no first-hand knowledge of these crops or of cotton. Our inherited experience had not taught us how to cope with their soil-destroying powers. Around 140 million acres of our best land were being plowed up and planted

Courtesy of Soil Cons. Service, U.S.D.A.

A New Jersey spinach field before terracing.

to these clean-cultivated crops annually before anyone realized what a disastrous effect they were having on the staying powers of the soil. But once this was clearly understood, immediate moves were made to apply correctives.

Modern farmers now avoid plowing their land whenever possible. Usually this either means finding some new methods of dealing with cultivated crops, or some substitute for them. In Missouri, for example, large acreages of corn have been replaced by winter barley, wheat, and rye. These small grains are grown year after year without plowing the land. The soil is merely

Courtesy of Soil Cons. Service, U.S.D.A.

The same spinach field after terracing.

redisked each fall and reseeded to the small grain. Lespedeza, seeded in the small grain, collects the necessary nitrogen from the air and provides profitable grazing for livestock.

In Nebraska, large-scale experiments are now under way in which the natural mulch of crop refuse is allowed to remain on the surface of the soil as a protective measure against loss of land by wind and water erosion. Seed are planted under this mulch and allowed to grow up through it. Thus, the soil is never turned upside down, but such working of the soil as is required is accomplished by the use of a duck-foot cultivator.

In New Jersey, the grassland system of farming, in which grasses and legumes are substituted for corn as silage crops, bids fair to revolutionize soil management systems on dairy farms. This does not mean that corn will be completely eliminated, but that the acreage will be confined to land which is so level, either naturally or by contour farming, that little loss of soil occurs by surface erosion.

Courtesy of Thomas D. Mulhern, Milltown, N. J.

Mercer County Agent A. C. McLean and H. W. Voorhees looking over the luxuriant growth of Italian rye grass in a corn field on the latter's farm.

If a good soil can be kept in place, the problem of making it continue to grow big crops is a relatively simple one. The "food" of crops consists of elements which have escaped into the ocean and the air, and which can be brought back to the land as required. The needed limestone and phosphate and potash fertilizers are obtained from ancient seas which are now dry land. The necessary nitrogen is captured from the air in immense nitrogen-fixing factories that, for military as well as agricultural reasons, are widely scattered over the earth. Some idea of the size of this problem is gained from the fact that our lime and fertilizer bill already amounts to approximately $200,000,000 annually.

Downhill Cropping Systems

But making an exhausted soil grow good crops presents a much more difficult problem than is involved in keeping a good soil good. In the first stages of soil depletion there is a tendency to follow "downhill" cropping systems in which crops with ever-increasing foraging powers are substituted for those which grow only on fertile soils. Thus, rye is often substituted for wheat, timothy for clover, buckwheat for oats, and poverty grass for bluegrass. If this process is continued, there comes a time when nothing worth while will grow, and there will be signs of malnutrition not only in the crops, but in the men and animals that eat these crops. At this stage, the usual procedure is to allow this exhausted land to run wild. It gradually recovers its productivity for better crops as the weeds, grass, shrubs and trees accumulate minerals from the subsoil and leave them behind on the surface in their refuse.

The difficulty with this process is that it takes too long. So, we try to substitute lime and fertilizers for time. However, in proportion as the soil has been exhausted of its fertility, it tends to compete with the crop for the chemicals that are applied. For a time, small amounts of fertilizer, applied in bands along the row, will meet the require-

(*Turn to page* 37)

Soil and Plant-tissue Tests as Aids in Determining Fertilizer Needs[1]

By George D. Scarseth

Soil Chemist, Purdue Agricultural Experiment Station, Lafayette, Indiana

¶ *Fifth of a series of practical articles dealing with the principles of soil fertility.*

WITHIN the last 10 years agronomists and soil chemists have given much attention to the development of rapid chemical soil test methods as a means of determining fertilizer practices (2, 6, 7, 8, 13). Numerous comparisons (1, 5, 10) have been made of the different methods used in the various states. One of the outstanding facts resulting from such studies is that no method has yet been devised that is infallible. This has brought on some criticism and doubt about the advisability of using such tests.

The criticism arises out of the tendency of the operator to expect too much of the tests. It is not reasonable to think that these soil tests in all cases should correlate closely with the crop responses obtained from the use of fertilizers nor with the true status of the soil fertility. The reason for this lack of correlation is obvious when some of the peculiarities involved are considered.

Limitations of the Chemical Soil Test. Plant roots absorb elements out of the soil slowly but continuously for several months, while in soil tests the solvents are in contact with the soil materials for only a few minutes.

This would not matter so much in inorganic systems where chemical equilibrium is rapidly established, but in the dynamic, biotic soil complexes it is of utmost importance. Another consideration is that plant roots differ in their feeding properties (12); for example, sweet clover and alfalfa can obtain more phosphate from a tri-calcium-phosphate in an alkaline soil than can corn or cotton. Soil tests, however, are usually designed for general crops and are not standardized for any particular crop or kind of soil. It is to be remembered that soil tests have extracting solvents differing variously in pH and composition from those of the different plant roots; and the presence or absence of free carbonates greatly affects the acidity of the solvent. Moreover, plants feed out of the subsoil as well as out of the top soil, thus soil samples usually do not represent the entire root environment. The plants absorb elements out of the whole soil complex, part of which may be alkaline (subsoil) and part acid (surface soil).

From this it seems clear that the chemical soil test methods can not be used as the sole guide in determining the fertility of soils. Nevertheless, if the user of such tests recognizes these limitations, the rapid chemical tests can be and are invaluable aids in diagnosing the fertility situation in the soil with respect to the static levels of fertility and the soil acidity. In the field of medicine, the determination of a sick patient's temperature with a thermometer is not the sole guide in diagnosing

[1] Presented before the meeting of the Association of Southern Agricultural Workers, Atlanta, Georgia, February 7, 1941.

the illness, but the thermometer is one of the valuable aids in making the diagnosis. Likewise the rapid soil test methods when properly used can be invaluable aids in the diagnosis of soil fertility.

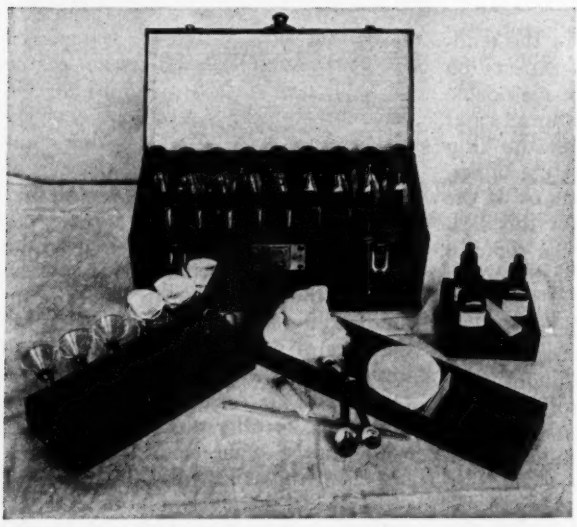
Plant-tissue Tests. Whereas the soil tests tend to indicate something about the static storage of readily available nutrients, the plant-tissue chemical tests developed at Purdue University appear to be another useful technique for determining the nutrient deficiencies of plants.

These tests were first applied by Hoffer (3, 4) in studying disease resistance of corn. The implantation of these tests in the field of plant nutrition grew out of this original work. The first tests were a direct method for nitrates and an indirect method for potash. Later they were supplemented by Thornton to include tests for phosphate and potash. The direct plant-tissue tests for nitrate, phosphate, and potash were combined by Thornton and others with the soil tests, and the necessary materials for all tests were put up in a convenient hand kit (11).

Much confusion in the early interpretations of the plant-tissue tests has held back this technique from proper recognition. The author has studied these tests intensely during the last three years and this paper is intended to point out some of the possibilities of the plant-tissue tests in diagnosing nutritional problems in plant production. Only a few typical case histories are presented.

The details of making the tissue tests have been described by Thornton, Conner, and Fraser (11). These tissue tests indicate which nutrient, particularly nitrate, phosphate, or potash, may or may not be the first limiting factor in the growth of a plant. The tests show in a roughly quantitative manner the presence or absence of these nutrients in unassimilated form. The elements that have been built into tissue parts are not indicated. In this manner this technique differs greatly from the method of foliar diagnosis of Thomas and Mack (9) or from a chemical analysis of plant tissues where the total amounts of the elements are determined whether assimilated or unassimilated.

Since growth will progress only as fast as the plants are able to absorb the nutrient that is present in the least amount, it is enlightening to determine what this particular nutrient is. No attempt should be made at interpreting the tissue tests until tests for nitrate, phosphate, and potash have been made. Most information can be obtained when considering the status of all these elements at the same time. A plant may be growing on a soil, for example, that is "low" in available phosphate and "high" in available potash according to soil tests. If nitrogen shortage should happen to be a more limiting factor than phosphate shortage, the tissue tests would show no nitrates present.

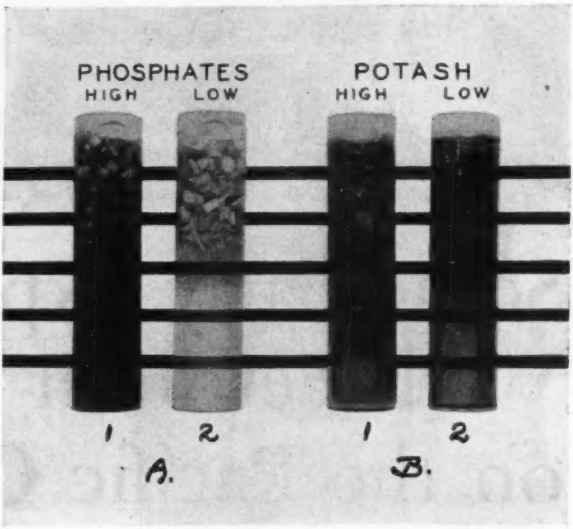


A Purdue Kit containing all reagents and equipment necessary for both soil and plant tests.

In such a situation, the tissue test for phosphate might show "high" in

spite of the fact that the available supply of phosphate in the soil was actually low. The potash test would also show "high." The reason for a high phosphate test, in such a case, is that the phosphate was unassimilated in the plant because the plant was too short of nitrogen for protein building, which would have used up the phosphate absorbed from the soil. Since the plant was not functioning normally because of the lack of nitrogen, the phosphate accumulated in the plant tissues, thus accounting for the high test. Investigators have frequently misinterpreted a high test for one of the three important nutrients as indicative of an abundance of such a nutrient in the soil, whereas a high test could mean an unassimilated factor. As soon as one limiting factor is removed a new one will develop unless all other possible elements are adequately supplied.

Case Histories in Diagnosing Nutritional Troubles. A few typical cases of the use of soil and tissue tests in diagnosing the fertility needs of plants will illustrate how the two types of tests have been used and what interpretations were possible.



Dark blue solution, A1, shows high inorganic phosphate; clear solution, A2, low phosphate. Dark yellowish brown turbidity, B1, shows high potash; lines can be observed, B2, with low potash.

Case 1.—Diagnosis of the causes of a poor growth of soybeans, Graysville, Indiana, July 20, 1938.

The soybeans over the whole field showed marked nitrogen-starvation symptoms. The plants in the limestone-dust strip nearest to the road were about 12 inches high, while those out in the field were about 6 inches in height. Soil and tissue tests were made with the results shown in Table 1.

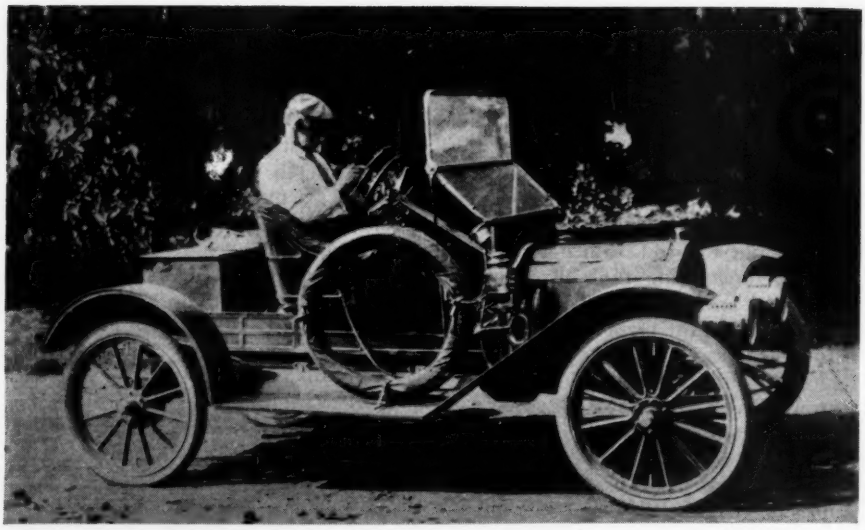
Interpretations of tests in Case 1.

1. The acidity tests showed that the area near the road, where lime dust from the graveled road had blown onto the field, had a favorable reaction, pH 6.3, yet the plants were starving for nitrogen because inoculation had failed to provide them with it. An inspection of the tissue tests showed that the plants were also starving for potash. This brings one to the conclusion that the rhizobia bacteria (nitrogen-fixing bacteria) were unable to function normally and supply nitrogen to the plants because the plants were too starved for potash to be carrying on normal metabolism. In other words, these plants were starving for nitrogen because of a lack of potash.

2. The lime dust had helped the soybeans near the road to grow a bit larger than those away from the road, but the lack of available potash prevented better growth. Here the limiting factors were potash, nitrogen, and phosphate in the order listed.

3. Back in the field, away from the road-dust effect, the pH was 5.3, which is too acid for the rhizobia bacteria to grow well. The tissue tests showed an excess of both phosphate and potash,

(*Turn to page* 43)



The author, back in 1910, ready to start out to talk fertilization with growers.

Some Early Experiences With Fertilizer on the Pacific Coast

By B. E. Maynard

San Jose, California

¶ *First of a series of articles recounting personal experiences with the use of fertilizer on the Pacific Coast during the past fifty years.*

AMONG my first observations, made before 1890, regarding the need of potash in California soils was that of noting the excellent effect of wood ashes on a strip of gravelly loam underlaid by a stratum of gravel, involving a few rows of grapevines on the edge of a small vineyard of about one acre in extent. These vines in the Santa Clara Valley near San Jose were about 20 years old, and had never been irrigated. It soon became evident to me that they were suffering from some form of malnutrition, but I knew of no one to turn to for advice.

On part of this strip no vines were growing, and so it was decided that this would be an excellent spot on which to burn the prunings from the vineyard, also prunings from some nearby pear trees. The brush was hauled out and deposited in a pile on this spot, allowed to dry, and then burned. Later on the ashes were scattered around the vines and plowed under. The vines thus treated showed marked improvement the first year, and in following

years became the most productive in the vineyard, producing large bunches of grapes excellent in quality, sweetness, and size. In fact one of these, an exceptionally large bunch, was displayed for several weeks in the window of a leading real estate office as evidence of the wonderful productiveness of Santa Clara Valley soils.

By this time my interest in potash was so thoroughly aroused that I carried my investigations still further by treating with wood ashes some young peach trees planted as replacements where old apple trees had been dug out. These trees were also unirrigated. The soil was a deep loam, considered rich and not in need of fertilization. With the exception of wood ashes no fertilizer or manure was used on these trees, but four rows of mangel-wurzel beets were grown annually in the space between the trees.

The ashes were broadcast around the trees and plowed under with the natural growth of winter cover crop. Some of the ashes, however, were applied close to the base of the trees in order to note if they would have any effect in controlling the peach-root-borer which at that time had made its appearance in California. The effect of this treatment with wood ashes seemed to be of some benefit, but probably due more to creating a loose, friable soil condition unfavorable to the welfare of this pest than to any other cause.

Trees Responded to Ashes

In spite of the competition of the beets for plant food, the peach trees responded remarkably well to this ash treatment—growing vigorously, quickly coming into bearing, and producing fruit excellent in size and quality. The finest fruit was not produced until the trees neared full production, and, as far as I know, was unequaled in size, quality, flavor, and color by any other peaches grown in the same district. The new wood growth was sturdy, strong, and well-matured. It would invariably fill out with large, plump, healthy bloom-buds, even following heavy crops. This bloom-bud formation meant regular and full production of peaches.

The beneficial results obtained from the use of potash as described above were not just guesswork on my part, but were amply proved by personal observations and comparisons made in certain neighboring peach orchards when picking fruit, and later when pruning the same trees after they had entered the winter period. When gathering the fruit from these neighboring

A properly fertilized Blenheim apricot tree in excellent condition after 50 years.

trees, many of the peaches were found to be decidedly inferior in size, color, and quality, and the trees generally were unthrifty in appearance. In pruning these trees, particularly following a reasonably heavy crop, the new growth of branches and twigs might be sufficient in length, but would be found to be puny and willowy in structure, the twigs almost string-like in texture. The bloom-bud formation would be very scant or none at all. Such conditions, would, of course, mean a very light crop, if any at all, the following season. These neighboring trees must be considered to have had an advantage over those treated with wood ashes as they

A fine Imperial prune tree starting to die-back because of potash deficiency.

were not resets, but original plantings. Also, they did not have to compete with beets for plant food. Soil was of the same type and texture, and apparently just as rich in natural fertility. Consequently, the difference in favor of the trees receiving wood ashes, as compared with those receiving none, could not well be attributed to anything but the potash so applied.

In the spring of 1892 I rented 55 acres of mixed orchard comprised of apricots, peaches, pears, French and Fellenberg prunes—the last better known on this coast as the Oregon prune—and about one acre in table grapes.

Two Distinct Soil Types

The soil in this place consisted of two distinct types. The higher ground, apparently glacial, contained much sharp, broken rock or gravel and boulders of varying sizes intermixed with a loam of a good mechanical type; a soil that should and did respond quickly to good care and fertilization. This upper land was separated from the lower level by a steep slope ranging from about 50 to 75 feet in height. The soil type of this slope, the greater part of which was planted to prune trees, was the same as described above, but rather difficult to work owing to the many boulders it contained. The lower level of about 15 acres consisting of a deep alluvial soil was planted to French and Fellenberg prunes, all in full bearing. This river-made soil would naturally be considered fertile, but quite the reverse was the case. When first seen by the writer, the trees were beginning to emerge from their winter dormancy, but their evident lack of thrift, string-like and puny twig growth, weak fruit-spur and bloom-bud formation, as well as die-back in many of the trees, and meager growth of weeds, plainly indicated the poverty of this soil.

Although deficient in organic matter, it was evident that it would respond quickly to good care and fertilization. The trees on this piece of land blossomed well that spring and set what apparently would be a good crop of fruit. Wanting more information regarding the fertilizer requirements of this soil,

samples were taken previous to blossoming time and sent to an authority on such matters, with a request for an analysis so as to determine what plant food elements should be applied in order to restore this piece of land to a fertile and productive condition. In reply it was stated that this type of soil was a familiar one and since analyses had already been made, it was not necessary to analyze the samples sent in; that nitrogen was needed to improve the size of the prunes; but that potash was present in abundance and would not be needed for thousands of years.

Hunger Signs Appeared

As the season progressed, however, the trees began to show unmistakable signs of hunger. Foliage was a sickly yellow in color, and twig growth insignificant and weak. Prunes of both varieties began to dry up at an early stage of growth, sometimes just one side of the fruit or a single spot would be affected. To the casual observer this condition could readily be mistaken for sunburn, but since it appeared on fruit not exposed to the sun, it indicated that sunburn was not the true cause of this trouble. Summer drop also was excessive, continuing right up to the time of ripening, by which time almost no crop was left. The few prunes remaining on the trees, instead of dropping normally as they should when ripe, were a lot of "stick-tights" that had to be beaten off. The resulting crop was only 500 pounds of green prunes per acre of the French and even less of the Fellenbergs. In drying the shrinkage was heavy, and the finished product so poor in sizes and quality as to be almost worthless.

Notwithstanding the report indicating that potash was not needed on this soil, I could not get the conviction out of my mind that the poor condition of these prune trees was due more to a lack of potash than to anything else. At the same time, judging from the slow maturity or ripening of the few prunes remaining on the trees after the summer drop was over, it seemed evident that phosphoric acid was needed. This impression was further corroborated by an examination of the pits taken from a number of prunes. It was found that the kernel formation was decidedly poor. My conclusion was, therefore, that phosphoric acid, as well as potash would have to be considered in the fertilization of these trees.

Following up this work in later years in other orchards apparently in good condition, except for light yields, an examination of the pit of the fruit was decidedly helpful in determining whether or not this tendency to light bearing was due to the trees not having a sufficient supply of available phosphoric acid to draw upon. If the condition of the kernel indicated a possible phosphate deficiency, applications of a phosphate fertilizer, or one with a high content of phosphoric acid, almost invariably would overcome this trouble by promoting a decided and regular increase in production. This increase was often apparent the first year. At the same time, growers who used or wished to use phosphoric acid alone or in connection with nitrogen were cautioned that increased production also meant an increase in the demand for potash which should be given full consideration if their orchards were to be maintained in a healthy and productive condition.

Search for Potash

Having decided to apply potash on this piece of bottom land, the question then arose, "Where could I obtain potash?" I knew that there were sources of potash other than wood ashes, but could find no advertisements, or other matter, in agricultural publications that answered this question. Finally I called upon a number of chemical concerns in San Francisco, but none seemed to be able to give the desired information. Not until getting in touch with the late Mr. George Meyer of Meyer, Wilson & Company, who were at that time importing potash, could I get any help in my quest. Through Mr. Meyer I at once found the solution of this problem.

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Oscar Bledsoe Makes Farm Science Work

By F. J. Hurst

Agricultural Extension Service, State College, Mississippi

IF INGENIOUS engineers and skilled craftsmen could design and build an automobile or airplane that could travel three times the average rate of all automobiles and airplanes, the machines would be considered new marvels of transportation and the designers and builders would receive world acclaim for their achievement. Unusual accomplishments in the field of agriculture usually are not as spectacular as achievements in the field of engineering and frequently go almost unnoticed, but, nevertheless, may contribute even more to the needs and welfare of the race.

Oscar Bledsoe, Greenwood, Mississippi, delta planter and president of the Mississippi Cooperative Staple Cotton Association, has made a remarkable record in soil-building and cotton production. Because he has put science to work on the farm, he has developed one of the most productive farming systems in the South. In 1939, Mr. Bledsoe produced an average of 826 pounds of lint cotton on 1,570 acres. This phenomenal yield was 3½ times the average yield for the Cotton Belt.

Nor was the remarkable yield of 1939 unusual as 10-year records will prove. The 1928-32 five-year average yield of lint cotton for the plantation before the present improvement program was inaugurated was 314 pounds per acre. The 1935-39 five-year average was 589 pounds of lint per acre. And, in 1940, one of the worst crop years in the history of the State, the yield was 650 pounds per acre.

"Selection of the best land, constant growth of clover, and fertilization of each cut of land according to its needs, have been basic factors in securing high production," says Mr. Bledsoe. A switch from long staple to short staple cotton, planting purebred seed of a high producing variety, planting at the right time, and cultivating the crop clean are other practices which Mr. Bledsoe has followed.

Scientific classification of the soil, combined with accurate records of yields, has been a basic factor in developing the cropping system on the plantation. All of the land has been classified and mapped according to soil type and

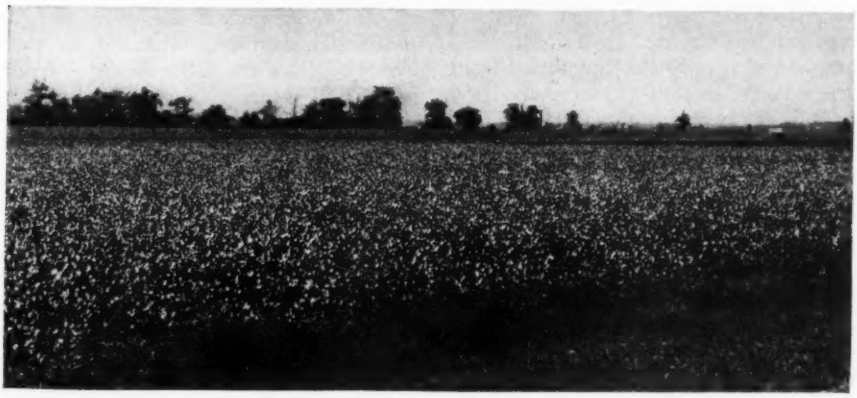
Although produced on third-grade land, oats yield a bountiful harvest.

productive capacity. Soil tests have been made and production records kept on every field. Hanging in Mr. Bledsoe's plantation office are two large maps. One of these maps shows by different colors the type of soil on every cut of land. The other shows by figures the actual yield of lint cotton on every cut.

Only the best land as determined by soil type and actual yields is planted to cotton. Cotton yields have been increased by the application of nitrogen and potash fertilizers. In 1939, when the record yield of 826 pounds of lint cotton per acre was produced, a 14-0-14 fertilizer was used. All land that does not produce a good crop of clover receives an application of the right amount of nitrogen and potash; and to be sure that any deficiency of phosphorus is corrected, all crop land in 1940 received an application of 150 pounds of superphosphate per acre. Mr. Bledsoe says, "We strive to put into the land everything that the plant needs."

Bur clover is grown on every acre of cotton land. This crop, which is plowed under as soon as the land gets dry enough in the spring, regardless of the stage of growth, adds humus and nitrogen to the soil, improves the physical condition and increases the moisture-holding capacity of the land. The application of mineral fertilizers supplies needed plant-food elements.

Only the Deltapine variety of cotton is grown on the plantation. Thirty pounds of pedigreed, delinted, ceresan-treated seed are planted per acre on a well-prepared, firm seedbed as soon after April 20 as weather conditions will permit. Ed Jones, capable plantation manager, says their records show that after the last of April every delay of one week in planting will cut the yield of cotton from 50 to 60 pounds of lint per acre. His aim in cultivation is to "keep the grass out." And he says, "Don't cover the cotton up when it is young, and don't plow it up when it is big."



In 1939 the plantation averaged 826 pounds of lint cotton per acre on 1,570 acres.

Mr. Bledsoe sells purebred Deltapine cotton seed as well as lint cotton. No other variety is ginned on his gins. All planting seed are delinted, ceresan-treated, sacked in 100-pound bags, and stored in warehouses.

Soil-building Program

An abundance of feed for plantation needs is produced on the farm. Corn is grown on second-grade land, oats on third-grade land, and alfalfa on a limited acreage to which this crop is adapted. Soybeans are interplanted in corn, and as soon as the corn is harvested, the beans are turned under to improve soil fertility. The thinnest land is planted to oats and seeded to crotalaria, which produces a green manure crop after the oats are harvested.

Thus, it will be seen that Mr. Bledsoe

has developed an intensive soil-building program by growing bur clover on all cotton land during the winter, by interplanting soybeans in corn and seeding crotalaria in oats during the summer, and by fertilizing all crops with superphosphate and by using nitrogen and potash wherever these mineral plant foods are needed.

Not until Mr. Bledsoe had his land classified and crop yields recorded did he realize the tremendous effect of soil type on production. In 1939, for example, yields of lint cotton varied from around 600 pounds per acre to 1,150 pounds per acre due to soil type alone. In fact, cotton on the less productive soil received even more attention than cotton on the best land, because Mr. Bledsoe wanted to bring all of the acreage up to a high productive level.

So important does Mr. Bledsoe consider soil testing and land classification that he has built and equipped an up-to-date soils laboratory and employed a graduate of Mississippi State College to make soil tests and keep production records. He hopes that within the next five years he will have information that will not only be profitable to him but helpful to other producers on similar land.

Turning again to bur clover because it plays such an important part in the soil-building program on the farm, Mr. Bledsoe saves seed patches every year and harvests from 15,000 to 20,000 bushels of bur clover seed annually. Negro women and children are employed to harvest the bur clover seed, which are swept up into piles with stiff brooms and sacked in second-hand bags.

The bulk of the bur clover crop is plowed under early in the spring to improve soil fertility. Turning of the clover begins early in the spring as soon as the soil is dry enough regardless of the stage of growth of the clover. Mr. Bledsoe explains that if he waited until all the clover reached the optimum stage before beginning to plow it under, it might be impossible to get it all turned under in time to thoroughly decay before seeding the next crop.

Since practically all of the land is cultivated by tenant families, Mr. Bledsoe has developed through years of study and experience a written agreement between landlord and tenant that assures equal and fair treatment to both. Comfortable housing, opportunity to make a good living, competent medical

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Bur clover is the main soil-building crop grown on the farm. Both tractor and mule power are used to turn the crop under.

Fig. 1. An airplane view of 14 acres of Muck Soil Experimental plots on Michigan State College Farm at East Lansing.

The Nutrition of Muck Crops

By Paul M. Harmer

Muck Specialist, Michigan State College, East Lansing, Michigan

THE important role which potash plays in the production of high yields of crops grown on muck* soils is fairly well recognized by those who have come in contact with this soil group. The effects of phosphate and sometimes of nitrogen, of sulphur and lime, and of salts of copper, manganese, sodium, and boron, in aiding in producing crop increases, as well as the effects of potash and some of the others in improving crop quality on certain muck soils, have not been so well understood. It also seems safe to say that the amounts of some of these materials, which are annually required on muck for the production of high crop yields, are likewise not generally appreciated.

The absence of any one of these plant-food elements in a muck soil is likely to result in a condition of malnutrition, which may be evident in some deficiency symptom in the growth of the crop. This may appear as an unnatural yellow coloring, a spotting, streaking, or some still different type of chlorosis of the leaves, a drooping or flattened growth of the plant, a cracking of the leaf stems or roots, an abnormal chemical composition of the crop, or some other indication of improper feeding. Since the highest yields of any crop can be secured only by keeping that crop in the healthiest possible condition throughout its growth, the proper balancing of these various plant-food nutrients becomes a matter of great importance in the fertilization of our muck soils.

Early investigations into the plant-food needs of crops, grown on the near-

* The term "muck" is used in this discussion in an all-inclusive sense for soils very high in content of organic matter, thus including peat as well as muck soils.

virgin mineral soils in many States, often failed to show any marked deficiency in supply of available potash in those soils. Since this situation continued for several decades before the need for potash became evident in the crop returns, conservative investigators were rightfully hesitant in revising their fertilizer recommendations. On the muck soils, on the other hand, the need for potash has been almost always immediate and outstanding, from the time the muck was first reclaimed. Yet even here, the adoption by farmers of a mixture containing sufficient potash has seemed comparatively slow. As recently as 1925, a fertilizer having an 0-10-10 analysis was considered as a high-potash muck mixture. Even in 1935, when considering the advisability of recommending an 0-8-40 mixture for certain muck crops, the writer was forced to drop the 0-8-32 analysis from his list of recommended mixtures, for a period of three years, because, in the restricting of the number of mixtures recommended by the group of experiment stations in which Michigan falls, it was decided at that time that the limited sale of 0-8-32 did not warrant its retention in the list.

Since muck soil is naturally so very low in content of phosphate and potash, a fairly good idea of the requirements of different crops for these two constituents can be secured from a consideration of the chemical composition of those crops. In Table 1 are presented the average amounts of phosphate and potash removed in good yields of several different crops, with the amounts expressed in the form of the fertilizer analysis and the rate of application which would be required to replace the quantities of these nutrients removed. These analyses range from as narrow a ratio of phosphate (P_2O_5) to potash (K_2O) as 1 to 2.1, in the case of rye,

TABLE 1.—SHOWING FERTILIZER ANALYSIS AND RATE OF APPLICATION THAT WOULD BE REQUIRED TO REPLACE THE PHOSPHATE AND POTASH WHICH IS REMOVED IN GOOD YIELDS OF SEVERAL DIFFERENT CROPS*

Crop	Bu.	Tons	Fertilizer analysis required to replace the phosphate and potash removed in crop	Rate of application Lbs. per acre
Grain and Corn Crops				
Barley, straw		2.2	0–8–58.4	114
Barley, grain	50		0–8–5.7	261
Total crop			0–8–21.8	375
Oat, straw		2.5	0–8–53.6	186
Oat, grain	60		0–8–5.1	181
Total crop			0–8–29.6	367
Rye, straw		2.0	0–8–32.8	126
Rye, grain	30		0–8–6.1	179
Total crop			0–8–17.1	305
Corn, stover		2.5	0–8–77.6	129
Corn, ears	60		0–8–6.2	276
Total crop			0–8–29.1	405
Average of grain and corn crops			0–8–24.4	363

TABLE 1—(Continued)

Crop	Bu.	Tons	Fertilizer analysis required to replace the phosphate and potash removed in crop	Rate of application Lbs. per acre
Hay Crops				
Alfalfa		3.0	0–8–40	361
Alsike clover		2.0	0–8–28.6	264
Hungarian millet		3.0	0–8–43.2	292
Meadow fescue		3.0	0–8–30.2	342
Reed canary grass		3.0	0–8–28.6	395
Sweet clover		3.0	0–8–40	327
Timothy		2.0	0–8–35.6	184
Timothy and clover		2.5	0–8–36	244
Wild marsh hay		1.5	0–8–36.2	77
Average all hay crops			0–8–35.4	276
Root Crops				
Sugar beet, tops		8.0	0–8–55.5	184
Sugar beet, roots		14.0	0–8–28.3	321
Total crop			0–8–38.2	505
Turnips, tops		5.0	0–8–24.2	229
Turnips, roots		16.0	0–8–38.8	367
Total crop			0–8–33.2	596
Carrots, roots		24.0	0–8–28	836
Mangels, roots		25.0	0–8–50.4	430
Parsnips, roots		15.0	0–8–27.3	689
Rutabagas, roots		16.0	0–8–43.3	458
Table beets, roots		18.0	0–8–44.2	412
Average all root crops (roots only)			0–8–37.2	500
Miscellaneous Crops				
Cabbage (above ground)		25.0	0–8–33.6	430
Celery (above ground)		25.0	0–8–30	1250
Onions, bulbs	800		0–8–19.6	504
Peppermint, hay		2.0	0–8–26	100
Potatoes, tubers	400		0–8–40.7	344
Tomatoes, whole fruit		25.0	0–8–42.3	430
Average all miscellaneous crops			0–8–32.0	509
Average all 26 crops			0–8–32.25	412

* Calculations based on chemical analysis of plant materials from Morrison's "Feeds and Feeding" and various other sources. Since the nitrogen removed in the crop may be largely or wholly secured from the muck soil itself, all consideration of that fertilizing element is purposely omitted in calculating the fertilizer analysis required to replace the fertility removed by the crop.

to as wide as 1 to 6.3, in the case of mangels. Six out of nine of the hay crops listed in the table, and four out of six of the root crops, show a ratio of phosphate to potash greater than 1 to 4. All but three of the 26 crops listed have more than a 1 to 3 ratio, while the average of the entire 26 shows a ratio of phosphate to potash of 1 to 4.03.

Attention should be called to the fact that the available analyses of the root crops in this table in some cases do not include the tops, inclusion of which generally would markedly increase the total amounts of the plant-food constituents required to replace those removed by the crop. On the other hand, the tops of these root crops usually are not removed from the field, therefore, the fertility in them largely remains in the soil. It should also be recalled that, in a muck soil even more than in other soils, potash is lost from the soil by leaching to a considerably greater extent than is phosphate. To compensate for this loss, an excess of potash always should be applied in the fertilizer mixture.

In any muck soil testing program for the determination of the content of plant-food nutrients, it is evident that, due to the leaching processes, the presence of a supply of potash in the soil in the fall or winter months is not an indication of the amount which will be present when planting time arrives. Consideration should likewise be given to the fact that, unlike mineral soils, most of the potash in the muck is in a water-soluble condition, with little reserve in the soil to replace the water-soluble potash when it has been exhausted by crop removal or leaching. On the other hand, phosphate, applied to the muck in excess of the crop requirements, is largely retained in a less available form in the soil as a reserve, which becomes available gradually as the previously available supply is removed. For that reason, a soil test, which shows a higher proportion of available potash than of phosphate in a high-yielding muck soil, is not an indication that the application of potash should be reduced, but rather that the condition is that of a healthy equilibrium, which should be maintained by a continued use of the fertilizer mixture that has produced this situation.

A systematic study into the fertilizer needs of muck soils was begun by Michigan State College in the spring of 1922. On a six-acre, leased field of slightly acid, deep muck, located three miles from the College, a series of plots was laid out with varying fertilizer mixtures and rates of application. For nine years these same plot treatments were repeated. With the experience gained from that set of plots, a new set of 14 acres, considerably more comprehensive than the first, was established on a deep muck on the College farm at East Lansing in the spring of 1931, so that 10 years of experimental data from this field have now been secured. Figure 1 shows an airplane view of the College muck field. In support of this central set of plots, a number of sets of from one to four years duration have been carried along in other parts of the State. Plans are now being made for a still more comprehensive muck experimental farm to be established in 1942 on 200 acres of deep virgin muck, located 11 miles from and owned by Michigan State College since 1855.

Fertilizing the crop. Probably the first important change resulting from these studies was the definite proof brought to our muck farmers that manure can be entirely dispensed with, provided a mineral fertilizer mixture high in potash content is used. After the muck has been farmed for a considerable period of years, an occasional green manure crop is grown, in order to supply live organic matter to the soil. The need for phosphate, along with the potash, is likely to appear in the very first crop on new muck, especially if such crops as onions and celery are being grown. It is almost certain to be needed within three or four years of cropping, even for hay

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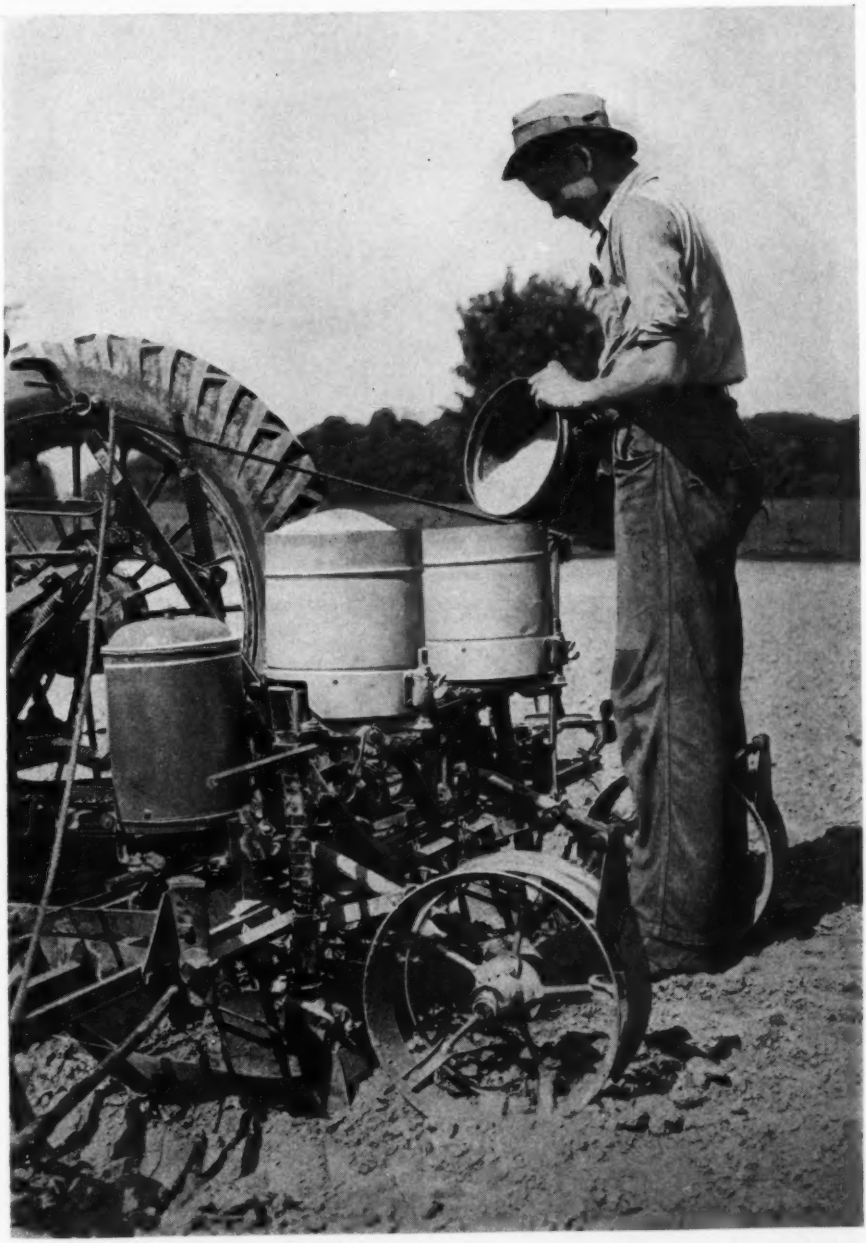
PICTORIAL



APPLYING FERTILIZERS AT PLANTING TIME SAVES LABOR AND HELPS THE CROP GET OFF TO A GOOD START.

Above: Stretching tent cloth over a shade tobacco field in the Connecticut Valley.

Below: Fertilizing the tobacco with materials for a short but speedy growing season.

Above: Grading and sacking potatoes on the farm of Wm. Gehring, Newlin, Indiana.

Below: Limestone rock quarry being stripped in Hopkins County, Kentucky.

Above: Line-up of teams to be judged at International Plowing Match, St. Thomas, Ontario, 1940.

Below: Eight-horse team of Premier M. F. Hepburn of St. Thomas, Ontario.

The Editors Talk

More Grass Less Labor

Farmers, like other employers, are watching the National Defense Program with more than a little anxiety over the loss or impending loss of employees whose services they value. Already reports of shortage of farm help all over the country are current. How some growers are planning to meet the problem was interestingly set forth in a short article recently received from Paul H. Allen, County Agent, Liberty, New York. Because the plan has application to many other regions, we are pleased to present his ideas below:

"The Number One problem on dairy farms in the Northeast this year is a shortage of farm help. With young men leaving for the Army and industry, the outlook for the immediate future is not too promising. As a result, farmers are beginning to think of ways to save time. They are trying all kinds of labor-saving devices and machinery, as well as giving more attention to labor efficiency in general.

"Dairymen on the heavier soils are beginning to wonder whether they have not been doing too much plowing. With a relatively large part of their farms under the plow, there is a peak in labor requirements at planting time in the spring and again during haying and harvesting. If the weather is unfavorable, the farmer short of help never gets caught up. On the other hand, dairymen who practice all-grass farming never appear to be in a rush. They make silage and hay all summer and the rain that delays their neighbors makes big crops for them.

"The trend towards more grass farming has been slow because we have lacked suitable perennial legumes and grasses. Timothy and clover seedings have to be renewed frequently, and few farmers will risk running short of roughage because they don't have enough silage corn. With yields of ten, fifteen, and even twenty tons to the acre, silage corn has been the most productive crop we have had in the Northeast until recently.

"Now we are finding that certain new types of seedings will actually outyield silage corn in the production of protein and total digestible nutrients per acre. Ladino white clover is the perennial legume we have long sought. Birdsfoot trefoil shows promise, and yellow trefoil is proving useful in many seedings. Orchard grass, especially the improved strains, perennial ryegrass, smooth brome grass, and some others have been found both productive and palatable to cattle.

"With these legumes and grasses, we are able to put down seedings that will produce high yields for several years. They can be used for grazing, silage, and hay and they will not deteriorate after the first years' cutting, as timothy, medium red and alsike clover seedings do.

"These new type seedings must be made in seedbeds adequately limed and fertilized with phosphorus, potash, and perhaps, in some cases, with minor

elements such as boron. Then they must be frequently cut and grazed if large yields are to be obtained. A cutting for the silo, a crop of hay, and one to three periods of grazing are possible each season.

"Really enormous yields have been reported from experimental plots at Cornell University. They run from two to more than three tons to the acre of material analyzing from fifteen to thirty per cent protein on a dry basis. Last season a yield of over four tons to the acre of material averaging twenty-two per cent protein was reported from a field of over forty acres. This is equivalent to a yield of about thirty-two tons of corn silage to the acre.

"In this particular case, the field was clipped frequently and the material either ensiled or dried artificially. The seeding consisted largely of an improved strain of orchard grass, perennial ryegrass, and Ladino white clover.

"The yield of digestible protein per acre amounted to well over three-quarters of a ton and of total digestible nutrients to more than two tons. This compares with two or three hundred pounds of protein and not more than a ton of T.D.N. from a good crop of ordinary hay and two hundred and fifty pounds of protein and a ton and three-quarters of T.D.N. from a crop of corn.

"Our present knowledge of grassland management would seem to justify dairymen in considering grass farming as a means of helping solve the labor problem without reducing the amount of roughage produced. Actually a modern system of grassland farming will make it possible to produce more nutrients on the farm and reduce the feed cost of producing milk."

Hybrid Corn's Popularity

Probably no new crop development ever received more publicity or took hold faster than the use of hybrid corn. Introduced to commercial growing about ten years ago, the crop has made phenomenal strides within the last five years. The first survey of the corn belt, made in 1938, showed the concentration of hybrid corn acreage in northern Illinois and east-central Iowa, and even there the hybrid made up less than three-fourths of the total corn acreage. In 1940, 77 per cent of the corn land in Illinois grew hybrids. Iowa reported a percentage of 88. It is believed that of the total corn plantings in the twelve north-central States, estimated at 49,544,000 acres, more than half was planted to hybrids.

With this remarkable acceptance comes the warning that hybrid corn is no substitute for soil fertility. C. M. Linsley, extension soil conservationist of the University of Illinois College of Agriculture, explains that hybrid corn is an efficient crop in using soil fertility to produce higher yields. Good hybrids have the ability to produce higher yields than open-pollinated because they have the ability to take up and use more fertility. However, many Illinois soils, after years of hard farming, cannot supply more fertility than an average crop of open-pollinated corn can use. Consequently, on these soils hybrid corn has little advantage in yields over open-pollinated.

Such warnings are most opportune. Too often, growers in their eagerness to increase yields lose sight of the necessity for a plant-food supply to support such yields. If hybrid corn is to retain its popularity, more and more attention will be paid to the fertility of the soil on which it is grown.

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

¶ A noteworthy study on periods of growth in which nutrients are taken up by pimiento plants is reported by H. L. Cochran and L. C. Olson in Georgia Experiment Station Bulletin 208. The title of this instructive publication is "Uptake of Nutrients by the Perfection Pimiento Plant Under Field Conditions and Its Relation to Fertilizer Practices in Georgia." During the past few years growers of this important cash crop in the lower Piedmont have experienced relatively small profits, due for the most part to low yields. The improvement in fruit type and better cultural practices cannot prove their maximum worth unless they are accompanied by a better knowledge of the nutrient needs of the crop. Data derived from a two-year investigation and presented here should go a long way toward fulfilling this need.

It is evident from the results given that the Perfection pimiento has a fairly large nitrogen, phosphorus, potassium, calcium, and magnesium requirement. An average of 243 pounds of nutrients was found in the above-ground portion of an acre of these plants. Of the total amount, 82 pounds were nitrogen, 56 pounds potash, 51.5 pounds calcium oxide, 36.5 magnesium oxide, and 17 pounds phosphorus. The greatest quantity of nutrients was absorbed during the third month of growth in the field. This amounted to 99 pounds per acre or 40.7 per cent of the total amount absorbed during the six-month growing season. Of the five nutrients considered, more potassium was taken up during any one single month than any other nutrient, followed by nitrogen, calcium, magnesium, and phosphorus. Details of these and other determinations are shown in charts and tables which accompany the text.

The authors conclude that proper fertilization of pimientos is necessary before much improvement in yield can be expected. A complete fertilization should generally be applied as a basic treatment in producing this crop regardless of the price received at the cannery.

¶ According to Michigan Extension Bulletin 159 (Revised), "Fertilizer Recommendations for 1941-42," the increase in use of commercial fertilizers is evidence that Michigan farmers are finding them profitable. Prepared by members of the Soils Department, who urge farmers to buy only fertilizers listed on the front of this Bulletin for good results and low plant-food costs, it predicts that the quantity used, especially by the more progressive farmers, should continue to increase. Fertilizer use on mineral soils should be in conjunction with good tillage, lime, green crops plowed under, rotation, manure, erosion control, and other good soil management practices. The intensive production of crops followed on muck soils requires special tillage and fertilizer practices.

Fertilizer analyses recommended are: 0-12-12; 0-20-20; 0-8-24; 0-8-32; 0-20-10; 0-14-6; 0-10-20; 2-12-6; 2-16-8; 2-8-16; 3-9-18; 3-12-12; 4-10-6; 4-16-4; 4-16-8; 5-10-5; 10-6-4; 0-20-0; the nitrogen carriers; and potash salts. As noted, the list comprises only those fertilizers containing 20 units or more of plant food. The authorities caution farmers that a

low price per ton for low analysis fertilizers does not mean cheap plant food.

"Recommendations for Soil Management and Use of Fertilizers," Ont. Dept. of Agr., Toronto, Ont., 1941.

"Fertilizer Recommendations for the Maritime Provinces of Canada," Maritime Fert. Council, Moncton, Canada, J. E. McIntyre, Sec.

"Home Mixing Fertilizers for Truck Crops," Agr. Exp. Sta., State College, Miss., Inf. Sheet 222, Dec. 1940, W. B. Andrews and J. A. Campbell.

Soils

¶ The first National Conference on Land Classification held in the United States was sponsored by the University of Missouri at Columbia, Missouri, in mid-autumn last year. Because of the value of such a record to scientists engaged in land classification work, the decision was made that the proceedings of this conference should be published in full as a bulletin of the Agricultural Experiment Station. Of particular interest to economists, soil scientists, geographers, engineers, foresters, and others, very valuable interpretations can be gained from the papers given and published in Missouri Experiment Station Bulletin 421, "The Classification of Land." Up-to-date material on land classification is brought together by scientists as far apart as Connecticut and California, Minnesota and Arkansas. There are also papers by specialists dealing with grazing problems, recreational lands, and public land policy.

According to Dr. M. M. Kelso, U. S. D. A., Bureau of Agricultural Economics, and Dr. Charles E. Kellogg, U. S. D. A., Division of Soil Survey, "The subject matter of papers might be classified roughly under four principal headings: (1) the materials of land classification, (2) the methods of land classification, (3) the objectives of land classification, and (4) the frame of reference within which land classification is done. Most speakers had something to say on two or more of these subjects, and it is not always clear when one is being discussed and when another. Yet this confusion, or lack of clarity, gives one an initial impression of greater disagreement among speakers than a closer analysis reveals."

The original idea of the Conference was conceived by Dr. C. H. Hammar, Professor of Agricultural Economics, College of Agriculture, University of Missouri. Arrangements were formulated by a committee of the College composed of Dr. Hammar as chairman; Professor O. R. Johnson, Head, Department of Agricultural Economics; Dr. W. A. Albrecht, Head, Department of Soils; Professor H. H. Krusekopf, Professor of Soils; and Dr. C. E. Lively, Head, Department of Rural Sociology. This committee was assisted, particularly in matters relating to the program, by members selected to represent the various agencies of the Federal Government that had shown interest in land classification.

"Saving Colorado's Soil," Agr. Ext. Serv., Fort Collins, Colo., Ext. Bul. 362-A, Sept. 1940, T. G. Stewart.

"Late Holding of Water on Cranberry Bogs," Agr. Exp. Sta., New Brunswick, N. J., Cir. 402, Oct. 1940, Charles S. Beckwith.

"Soil Losses From Cultivated Strips in Strip-cropped Fields in the Ohio Valley Region," U. S. D. A., Washington, D. C., Cir. 588, Dec. 1940, R. W. Gerdel.

Crops

¶ Virginia Truck Experiment Station Bulletin 105, entitled "Vegetable Crops Affected by Boron Deficiency in Eastern Virginia," by E. R. Purvis and W. J. Hanna, presents results of field tests showing that applications of borax in several areas have resulted in increases in yield or quality with a majority of the vegetable crops grown in Eastern Virginia. Boron deficiency, the authors state, has been found to affect at least 16 vegetable crops grown under field conditions in this section of the State as evidenced by growth response to applied borax, or the appearance of malnutrition symptoms in plants.

Vegetable crops are classified according to their tolerance to applied borax as determined by field and greenhouse studies. This classification shows that, assuming normal rates of fertilizer application, borax at the rate of 10 pounds

per ton may be safely mixed with fertilizers used for all vegetable crops grown in Eastern Virginia. Precautions necessary for the avoidance of injury in applying borax are stressed.

On soils where any one crop is affected by boron deficiency, it is recommended that borax be applied at the rate of not more than 10 pounds per acre for the following crops: beets, carrots, cauliflower, celery, corn, eggplant, kale, lettuce, mustard, peppers (sweet), potatoes, sweet potatoes, radishes, tomatoes, and turnips. In cases of the more deficient soils, more than 10 pounds of borax per acre will have to be used for certain crops. In such instances, it is advised that the grower consult the Truck Experiment Station before using amounts greater than 10 pounds per acre.

Although certain of the light Norfolk soils have been found to be extremely deficient in boron, this condition is not general with a majority of the trucking soils of Eastern Virginia, where only limited deficiency exists.

The extensive investigations reported were begun in 1938 in an effort to establish the extent of boron-deficient soils in this area, as well as to determine what vegetable crops were affected by this deficiency, and to classify locally grown vegetable crops according to their tolerance to applied borax. The results obtained will be of infinite value to vegetable growers in Virginia and other States whose soils similarly require attention to boron applications.

"Handbook of Alabama Agriculture" (Third Edition), Ala. Ext. Serv., Auburn, Ala., 1941.

"Effect of Date of Planting on Corn Yields, Insect Infestation, and Fungus Diseases," Agr. Exp. Sta., University, La., Bul. 327, Jan. 1941, D. M. Johns and H. B. Brown.

"Commercial and Experiment Station Corn Yield Trials, 1940," Agr. Ext. Serv., University Farm, St. Paul, Minn., Ext. Pamphlet 75, Jan. 1941, Ralph F. Crim.

"A Laboratory Study of the Drainage Requirements of Sweet Clover," Agr. Exp. Sta., University Farm, St. Paul, Minn., Tech. Bul. 144, June 1940, P. W. Manson.

"Sweetpotato Plant Production in Mississippi," Agr. Exp. Sta., State College, Miss., Bul. 349, Oct. 1940, W. S. Anderson.

"Tomato Experiments—1940," Agr. Exp. Sta., State College, Miss., Inf. Sheet, 225, Dec. 1940, J. A. Campbell.

"Management of Korean Lespedeza," Agr. Exp. Sta., Columbia, Mo., Cir. 210, Dec. 1940, C. A. Helm.

"Serving Montana Agriculture Through Research," Agr. Exp. Sta., Bozeman, Mont., 46th and 47th An. Rpts., July 1, 1938, to June 30, 1940.

"Effect of Ensiling Upon the Composition of Forage Crops," Agr. Exp. Sta., New Brunswick, N. J., Bul. 683, Nov. 1940, M. Wight Taylor, C. B. Bender, and Walter C. Russell.

"Inoculation for Legumes," Agr. Exp. Sta., Geneva, N. Y., Cir. 179, Rev. Dec. 1, 1940, A. W. Hofer and J. K. Wilson.

"Flue-cured Tobacco," Agr. Ext. Serv., State College Station, Raleigh, N. C., Ext. Cir. 212, Rev. Jan. 1941, E. Y. Floyd and L. T. Weeks.

"Azaleas," Agr. Ext. Serv., State College Station, Raleigh, N. C., Cir. 246, Jan. 1941, James G. Weaver.

"The Massey Strawberry," Agr. Exp. Sta., State College Station, Raleigh, N. C., Bul. 327, Aug. 1940, George M. Darrow and E. B. Morrow.

"The Trailing Raspberry—Rubus Parviflolius L.—Characteristics and Breeding," Agr. Exp. Sta., State College Station, Raleigh, N. C., Tech. Bul. 65, Aug. 1940, C. F. Williams and George M. Darrow.

"Growing Ornamental Greenhouse Crops in Gravel Culture," Agr. Exp. Sta., Wooster, Ohio, Bul. 616, Dec. 1940, Alex Laurie and D. C. Kiplinger.

"Science Serving Agriculture," Agr. Exp. Sta., Stillwater, Okla., Biennial Rpt., 1938-1940, Dec. 1940.

"Operation of Webber Demonstration Farm, 1929-1938," Agr. Exp. Sta., Brookings, S. D., Cir. 31, Nov. 1940, C. Larsen.

"Fifty-second Annual Report—1939," Agr. Exp. Sta., College Station, Tex.

"Ripening Fall and Winter Pears," Agr. Ext. Serv., Pullman, Wash., Ext. Bul. 258, Nov. 1940, John C. Snyder.

"Filberts," Agr. Ext. Serv., Pullman, Wash., Ext. Bul. 263, Jan. 1941, John C. Snyder.

"Epistle to the Farm," Agr. Exp. Sta., Morgantown, W. Va., Bul. 298, Dec. 1940, Rpt. of Dir., Biennium 1938 to 1940, C. R. Orton.

"What's New in Farm Science," Agr. Exp. Sta., Madison, Wis., Bul. 450, Dec. 1940, An. Rpt. of Dir.

"Report of The Puerto Rico Experiment Station, 1939," U. S. D. A., Washington, D. C., Oct. 1940.

"Disease-resistant Varieties of Vegetables for the Home Garden," U. S. D. A., Washington, D. C., Leaf. 203, 1940, R. J. Haskell and V. R. Boswell.

"Report of The Chief of The Bureau of Agricultural Chemistry and Engineering, 1940," U. S. D. A., Washington, D. C.

"Report of The Chief of The Office of Experiment Stations, 1940," U. S. D. A., Washington, D. C.

"Report of The Chief of The Bureau of Plant Industry, 1940," U. S. D. A., Washington, D. C.

"Report of The Director of Information, 1940," U. S. D. A., Washington, D. C.

"Lespedeza Culture and Utilization," U. S. D. A., Washington, D. C., Farmers' Bul. 1852, Nov. 1940, Roland, McKee.

"The Maytime, Starbright, and Redstar Strawberries," U. S. D. A., Washington, D. C., Cir. 597, Dec. 1940, George M. Darrow.

"The Atlantic Pemberton, and Burlington Blueberries," U. S. D. A., Washington, D. C., Cir. 589, Dec. 1940, George M. Darrow and J. H. Clark.

Economics

¶ The cost of production in agriculture is a widely varying factor, but is perhaps the most important one affecting farm income. In Special Bulletin 305, "Sugar Beet Costs and Returns," of the Michigan Agricultural Experiment Station, Mr. K. T. Wright has presented a nice analysis of the factors affecting cost and return from sugar beet production in this section of the United States.

Sugar beets are an important crop in Michigan, providing farmers with an annual cash income of approximately 5 million dollars. Michigan usually ranks third or fourth in sugar beet production in the United States. The other three leading sugar beet-producing States are Colorado, California, and Nebraska.

Data for the Bulletin was provided through an analysis of 279 sugar beet cost records kept by producers over a 4-year period, 1933 to 1936. The average farms on which sugar beets were grown consisted of about 150 acres, with 115 tillable. The crops grown consisted of: sugar beets about 15 acres, beans—10, hay—22, corn—17, small grains—31, miscellaneous crops and tillable pasture—20. On the average farm there were about 10 cows, 2 brood sows, 15 ewes, and about 100 hens. The average production cost per acre for sugar beets was $39 per acre, and marketing costs amounted to $9 an acre, making a total cost of $48. The average income amounted to $70 an acre, leaving a net return of approximately $22 an acre. Hand work constitutes the major part of the labor involved in the production of sugar beets. Out of a total of 85 hours of man labor spent per acre, 70 hours were hand work and 15 hours were taken up with other operations.

The most significant figure in production costs is that relating to the cost per unit. Production cost per ton averaged $4.03, but there was a rather wide variation from farm to farm. The marketing cost was 89 cents per ton, making a total average cost of $4.92 per ton delivered at the plant.

Receipts from the sugar plants averaged $6.08 per ton during the 4-year period. Government payments and credit for tops brought the total to $7.12 per ton, which was $2.20 above the cost. The production cost per ton varied from approximately $3 to $10, but a range of 80¢ per ton on each side of the average included one-half of the growers, while a range of $1.20 included two-thirds of the growers. In other words, about half of the growers had a production cost which was between $3.20 and $4.80 per ton, and two-thirds of them fell within $2.80 to $5.20 a ton.

Yield per acre is one of the most important factors determining production cost per unit. The growers having yields of around 6½ tons per acre had a production cost of $5.74 per ton as compared to $3.21 per ton for those averaging approximately 13 tons per acre. The net return per acre was more than 10 times as high for the high-yield producers as for the low-yield.

The author includes such variables as soil type, drainage, amount of manure and fertilizer applied, time of plowing and planting, and row width as the most important factors affecting the yield per acre and cost per ton. He considered other factors, including acres of beets per farm, the grower's efficiency with labor, power and machinery, and the hand labor method, as having considerable effect on the cost per acre and consequently per ton

of beets. The distance to the plant, of course, had an important bearing on the marketing cost and consequently on the net return from the beets.

An analysis of the records of three low-cost growers showed that the grower who was lowest in cost had a four-year average production cost of slightly less than $3 per ton. "This man averaged 13.5 tons of beets per acre on about 10 acres of beets each year. His soil was well-drained Brookston. Corn or beans occupied the field the year preceding the sugar beets, and the ground was not plowed for beets three of the four years of the study. The beets were planted May 7 as an average, in 22-inch rows, with a desired spacing of 12 inches in the row. More than 500 pounds of 2-12-6 commercial fertilizer was applied per acre, and manure was used half the time, two years before the beets occupied the ground. . . .

"The grower ranking next in cost, had an average production cost of $3.34 a ton. He averaged 12.7 tons of beets per acre on slightly less than 10 acres. The soil was of the Brookston type with fair drainage. The sugar beet field was in corn the preceding year in two of the four years, beans once, and buckwheat once. The ground was fall-plowed three years and spring-plowed one year. This man, located in the northern edge of the sugar beet area, planted his beets May 16 as an average, in 24-inch rows, with a spacing of 10 inches in the row. From 175 to 200 pounds of 4-16-4 commercial fertilizer were used, and manure was used as a top-dressing two years, and a 10-ton application was applied once, the year before the beets. . . .

"The grower ranking third had an average production cost of $3.46 a ton for the four years. His average yield was about 13 tons per acre on approximately 30 acres of beets. The soil was well-tilled Napanee. The beets usually followed corn, although sometimes clover or wheat. The ground was fall-plowed each year. The average planting date for this grower (in the southern part of the beet area) was May 5. The beet rows were 22 inches apart, and the spacing in the row was 12 to 14 inches. Commercial fertilizer applications ranged from 250 to 350 pounds per acre, and there was usually a light application of manure the year before the beets."

"Fertilizers Used in Alabama, Season of 1940," Ala. Dept. of Agr. and Inds., Montgomery, Ala.

"Commercial Fertilizer Sales as Reported to Date for the Quarter Ended Dec. 31, 1940," Dept. of Agr., Sacramento, Calif., Bu. of Chem. Ann. FM-17, Feb. 14, 1941.

"Connecticut Vegetable Acreages—1938, 1939, and 1940," Dept. of Agr., Hartford, Conn., Bul. 69, Dec. 1940.

"Agriculture and National Defense, Delaware Farm Family Outlook—1941," Agr. Ext. Serv., Newark, Del., Ext. Cir. 44, Jan. 1941.

"The Analysis of Lattice and Triple Lattice Experiments in Corn Varietal Tests," Agr. Exp. Sta., Ames, Iowa, Res. Bul. 281, Sept. 1940, Gertrude M. Cox, Robert C. Eckhardt, and W. G. Cochran.

"A Farm Management and Cost Study of Strawberry Farms in Southeastern Louisiana, 1937-38," Agr. Exp. Sta., University, La., Bul. 326, Jan. 1941, J. Norman Efferson.

"A Cost of Production Study of Tomatoes in North Louisiana, 1939," Agr. Exp. Sta., University, La., Bul. 329, Jan. 1941, T. M. Montgomery, Jr., and J. Norman Efferson.

"Commercial Fertilizers, 1940," Agr. Exp. Sta., Orono, Me., Off. Insp. 177, Oct. 1940, Elmer R. Tobey.

"Inspection of Agricultural Lime Products," Agr. Exp. Sta., Amherst, Mass., Control Series, Bul. 106, Oct. 1940, Philip H. Smith and J. W. Kuzmeski.

"Fertilizer Analyses and Registrations—1940," Dept. of Agr., St. Paul, Minn.

"A Survey of Practices and Costs of Producing Grass Silage on 50 New Jersey Farms," Agr. Exp. Sta., New Brunswick, N. J., Bul. 684, Oct. 1940, John W. Carncross, Allen G. Waller, and Emil Rauchenstein.

"Land Use and Crop Practice Survey—Franklin and Harrison Townships, Gloucester County," Agr. Exp. Sta., New Brunswick, N. J., AE 36, Jan. 1940, Allen G. Waller and John W. Carncross.

"North Carolina Cotton Prices and Local Marketing Practices," Agr. Exp. Sta., State College Station, Raleigh, N. C., Tech. Bul. 64, June 1940, Glenn R. Smith.

"Price of Coffee in Puerto Rico from 1900 to 1938," Agr. Exp. Sta. Río Piedras, P. R., Bul. 54, Apr. 1940, Jorge J. Serrallés, Jr., and Martín Vélez, Jr.

"The Food Supply of Puerto Rico," Agr. Exp. Sta., Río Piedras, P. R., Bul. 55, Aug. 1940, E. B. Hill and J. R. Noguera.

"Costo De Producción De Tabaco en Puerto Rico, 1937-38," Estación Exp. Agr., Río Piedras, P. R., Boletín 56, 1940, Roberto Huyke y R. Colón-Torres.

"Summary of Fertilizer and Fertilizer Materials and Customers Mixtures Sold in South Carolina as Reported by Manufacturers for the Period July 1, 1940, through December 31, 1940," Clemson Agr. Col., Clemson, S. C., Feb. 10, 1941.

"Inspection and Analysis of Commercial Fertilizers," Agr. Exp. Sta., Clemson, S. C., Bul. 330, Oct. 1940, B. D. Cloaninger.

"Planning the Farm Layout and Cropping System," Agr. Ext. Serv., Knoxville, Tenn., Pub. 245, Nov. 1940, H. C. Holmes.

"Farm Management Aspects of Soil Conservation on Flue-cured Tobacco Farms in Virginia," Agr. Exp. Sta., Blacksburg, Va., Bul. 327, Sept. 1940, W. L. Gibson, Jr.

"Alabama Handbook, 1941 Agricultural Conservation Program," U. S. D. A., Washington, D. C., SRB-501—ALA, Dec. 1940.

"Louisiana Handbook, 1941 Agricultural Conservation Program," U. S. D. A., Washington, D. C., SRB-501-LA, Jan. 1941.

"Mississippi Handbook, 1941 Agricultural Conservation Program," U. S. D. A., Washington, D. C., SRB-501-MISS, Dec. 1940.

"South Carolina Handbook, 1941 Agricultural Conservation Program," U. S. D. A., Washington, D. C., SRB-501-SC, Jan. 1941.

"The Farmer's Share of the Consumer's Food Dollar," U. S. D. A., Washington, D. C., Leaf. 123, Rev. Dec. 1940.

"European War, National Defense, and American Agriculture," U. S. D. A., Washington, D. C.

"Three Principles of Agricultural Cooperation," Farm Credit Admn., Washington, D. C., Cir. E-24, Ward W. Fetrow.

"Report of The Director of The Office of Foreign Agricultural Relations," U. S. D. A., Washington, D. C., 1940.

"Report of The Chief of The Commodity Exchange Administration, 1940," U. S. D. A., Washington, D. C.

"Report of The Consumers' Counsel, 1940," U. S. D. A., Washington, D. C.

"Report of The Chief of The Bureau of Agricultural Economics, 1940," U. S. D. A., Washington, D. C.

"Some Factors Affecting Fertilizer Consumption," U. S. D. A., Washington, D. C., F. M. 10, Dec. 1940, A. P. Brodell and M. R. Cooper.

"Gross Farm Income and Indices of Farm Production and Prices in the United States, 1869-1937," U. S. D. A., Washington, D. C., Tech. Bul. 703, Dec. 1940, Frederick Strauss and Louis H. Bean.

Oscar Bledsoe Makes Farm Science Work

(*From page* 18)

attention and adequate hospitalization, and good management are afforded every tenant family on the plantation.

Practically all of the tenant families raise a good garden, keep one or more milk cows, produce most of their meat supply, and produce and conserve other food products.

Under the terms of the written agreement covering the acreage to be planted in cotton, which is determined by the landowner for each family on the basis of the amount of cotton the family can pick, 40 per cent of the net income from all cotton and cottonseed is paid to the tenant for his and his family's labor, small tools, and cotton sacks; 40 per cent goes to the landowner for living quarters for the tenant family, cotton land, planting seed, fertilizer, if any is used, or winter cover crops, if planted; and 20 per cent to either party furnishing plow tools, workstock, and feed.

Tenants are financed on the basis of the number of acres in cotton and are advanced cash monthly for living expenses. They are charged a fixed but nominal sum for medical attention and hospitalization, protective poison, supervision and necessary tractor work, any day labor hired and cotton picked, and are credited with any labor performed for other tenant families.

The tenants benefit from the efficient handling and selling of the cotton crop, which is sold on the basis of actual grade and staple. The plantation price of cotton is fixed at ½ cent less than the U. S. Bureau of Agricultural Economics' price at Memphis, Tennessee, which is to cover drayage, storage, and insurance, at the time the cotton is stored, sold, or upon the final settle-

ment. The cotton is also sold on the basis of weights determined by U. S. bonded weighers. This system assures the maximum return for his share of the cotton crop.

A modern clinic has been built on the plantation and a full-time physician employed to administer to the sick. Clinics are conducted each day for the control of certain diseases. This system assures each tenant family modern hospital and medical service at a minimum cost. Marked progress has been made in control of infectious and contagious diseases, and the general health and vigor of tenant families have been improved. The results indicate that for better rural health, the system is not only economical, costing each family very little, but it is highly effective.

Gardening Without Soil

(*A Book Review*)

An appropriate addition to the list of publications dealing with hydroponics, or soilless growing of plants, is "Gardening Without Soil" by A. H. Phillips (Chemical Publishing Co., Inc., New York, N. Y., 1940. $2.00). With the comparatively large number of excellent and indifferent works already published dealing with this rather new and somewhat limited field of biology, one may wonder where there is place for another. This volume is distinguished from the others in that it was written from the English viewpoint, all the other works having been written by Americans.

Mr. Phillips has not written a critique of soilless culture, since his book is more in the nature of a practical handbook for the purpose of introducing the practice to the amateur gardener. The author apparently has made a careful and first-hand study of the subject in the United States and carried on work himself with growing plants in media other than soils.

The introduction deflates some of the wild claims made for soilless culture, and furnishes the basis of a sane approach to this interesting and intriguing type of gardening. The first chapter gives a few principles of plant physiology and nutrition which are little enough background for the average person who is delving into water culture for the first time. The next chapter deals with water culture specifically, telling how to prepare tanks, and provide supports, light, aeration, and heat, with considerable emphasis placed on the importance of the latter. The third chapter takes up some of the modifications of water culture, which the author groups under the term of aggregate culture. This includes sand, gravel, cinders, and other materials used as the medium in which the plant roots grow.

Chapter four goes into the preparation of nutrient solutions in some detail, while the fifth chapter considers some of the problems connected with soilless culture. A helpful section describes briefly the typical appearances of plants when they are over or under supplied with the various nutrient elements, as well as giving the principal functions performed by the elements. The final chapter takes up a phase of the subject that is different in that it considers the use of soilless culture technique on the farm as a practical supplement to orthodox practices. Most of this is devoted to the growing of sprouted grain for cattle and poultry feed, in which apparently there is much interest in Great Britain in order to provide more vitamins in the diet. The subject is presented in a nontechnical manner that can be easily understood, and the book should be useful to those who are beginning to take up the soilless culture of plants.

Some Early Experiences with Fertilizer

(*From page* 15)

He not only informed me from whom potash could be obtained, but kindly gave me literature of a helpful nature, as well as other information of value.

Owing to the general teaching and belief at that time to the effect that potash was not needed in California soils and that to apply it to our crops would be a waste of time and money, but little potash was sold in this State. Undoubtedly the bulk of all that then came into San Francisco was intended for use elsewhere.

On learning where potash could be obtained, I lost no time in placing my order, which was given to the Pacific Bone-Coal and Fertilizing Company. In addition to the potash a 6-8 tankage was included in the order so as to supply nitrogen and phosphoric acid, the need for which was also recognized. For use as a general fertilizer, the potash and tankage with the exception of a few sacks reserved for experimental purposes, were mixed in proportions to make a 4½-6-12½ fertilizer, a formula containing 23% of actual plant food. This was applied at the rate of 680 pounds per acre to all the French prunes, except a few trees which were left untreated for further observation. Not having enough to cover the entire piece, only 66 of the 300 Fellenberg prune trees received the fertilizer. The application was made early in January and a heavy rain prevented working it into the soil.

Fertilizer Brings Clover

The effect of this application was particularly surprising on clovers which previously were not known to exist on this soil. They grew "like mad," attaining by the middle of March a height of fully two feet, forming a dense mat as far as the fertilizer went; the roots were massed with nodules indicating that the plants were getting an abundance of nitrogen from the atmosphere. In a space of only 28 square yards, seven varieties of clover were counted although in after years bur clover, by the density of its growth, crowded out all the others. No clover appeared on the untreated ground, and what little vegetation started was scant, making almost no growth whatsoever and scarcely attaining a height of two inches for the entire season. Not only did the use of this fertilizer provide the soil with needed phosphates and potash, but by bringing about such a remarkable growth of clover it solved the problem of supplying humus, and incidentally nitrogen as well.

Trees Respond Well

The response by the trees was all that could be expected the first year. Foliage was excellent and the trees set a good crop of fruit which went through the summer with very little drop. The prunes were free from the so-called "sunburned" spots that formerly were so prevalent, and sizes were better. The French prunes matured earlier, ripened, and dropped normally without having to be beaten off as before. This second year the French prunes averaged fully 5 tons green fruit per acre which ran 55 to the pound when dry, against my first year's crop of only 500 pounds green prunes per acre ranging when dry from 90 to 150 to the pound. The Fellenberg prunes, however, outdid themselves. The 66 fertilized trees averaged 200 pounds of excellent fruit per tree which was sold green, whereas the untreated trees were just as unproductive as formerly.

The following year, to better determine the effect of phosphoric acid on the setting of fruit, about 50 French prune trees which had received the tankage-potash treatment were given an application of basic slag alone. The better setting of fruit as far as this application went showed decidedly the favorable influence of phosphoric acid.

In this case, however, the set was excessive; consequently, the prunes, although they matured normally, were reduced in size, and somewhat in quality. The bur clover crop made an excellent growth among all the trees that previously had received the tankage potash fertilizer, but was still further increased by the basic slag.

Looking back over this period of more than 50 years ago, and the hundreds of careful observations made since then on crops and fruits under varying climatic and soil conditions, establishes the accuracy of the conclusion I had come to before 1890—that many California soils were in need of potash, as well as other fertilizers.

Soil, the Substance of Things Hoped For

(*From page* 8)

ments in getting the crop started, after which it forages fairly effectively for itself. But the net effect of this procedure is to still further exhaust the soil and subsoil of their supply of nutrients.

The time finally arrives when the soil becomes a highly effective competitor against the crop for any fertilizer that is applied. To fully meet the requirements of crops like corn and alfalfa then becomes a difficult problem since, out of every 100 pounds of phosphoric acid applied, the soil may fix 80 of them, leaving only 20 for the crop. Similar difficulties are experienced in the case of potash. In fact, the situation with respect to potash is now such that enormous increases in the rate of application of this nutrient will be required throughout a large part of this country, if its lack is not to be a seriously limiting factor in crop production.

But lime and fertilizer alone do not meet the requirements in building up poor soils. One can not substitute chemicals for sod and its soil-improving effects. If he applies his lime and fertilizer and goes ahead with the same old plowing and clean-cultivation procedures, the soil will still move downhill. And the longer this process is continued, the faster this movement takes place. It finally reaches the point where we are constantly faced with the necessity of making new soil out of subsoil. While this can be done, it is an expensive procedure.

It is high time that we gave more consideration to the development of soil management systems in which there is a judicious mixing of soil-resting crops and clean-cultivated crops, if these latter must be grown. And when we rest the land, there is need to put some thought into just how we can make the most of the time the land is kept out of production of money crops. This calls not only for the growing of some type of sod-forming crop, but for feeding this crop so well that it can develop a good root and a good top growth. The crop should be made to produce its maximum effect on the soil, both while it is being grown and after it has been plowed under.

Benefits Carried Over

It is of importance to keep in mind that a given portion of fertilizer can be used over and over again by plants if these plants are plowed under. Thus, a well-fertilized sod or cover crop, when plowed under, yields up its load of fertilizer to the next crop when it decays. The fertilizing of a high-priced cash crop can well begin a year or more ahead of time, by applying the fertilizer to a previous soil-improving crop.

When we plow down a well-fertilized sod or cover crop, the effects produced are much the same as those obtained by plowing under manure. The combination of organic matter, limestone, and fertilizer at plow depth is exactly what is required to encourage deeper roots. With these deeper roots goes greater foraging power for the water and fer-

tility elements that are located in the subsoil. Plants so fed are not nearly so likely to suffer from drought as those which must depend on row applications of fertilizer and only small amounts of organic matter.

The problem of soil management resolves itself largely into a planned program designed, first, to keep the soil in place, and, second, if the land must be plowed, to have it so well stocked with organic matter that it will suffer little loss from the action of wind and water. Sooner or later we have to pay the price if soils are mismanaged. At first, this may only mean an unprofitable agriculture on an occasional farm. In time, it may mean a decadent agriculture over a whole county, state, or nation.

The Nutrition of Muck Crops

(*From page 22*)

crops. In Table 2 are given the average increases, over the average of the unfertilized plots, in yields of potatoes and onions on the College muck plots, which have resulted from the application of different mixtures of phosphate and potash. Although potatoes show an increase in yield with increase in potash up to and including the heaviest potash application (plot 7), onions are one of only two of the many crops grown which have given a decrease in yield with an excess of potash. The fertilizer recommendations presented in Table 3 are based on the results of these 19 years of experimental study.

Nitrogen. Since muck soils generally contain from one and one-half

TABLE 2*—SHOWING INCREASES IN YIELD OVER THE UNFERTILIZED PLOTS RESULTING FROM THE APPLICATION OF VARYING PROPORTIONS OF PHOSPHATE AND POTASH ON A REPRESENTATIVE CROP ON EACH OF TWO SETS OF PLOTS—COLLEGE MUCK, EAST LANSING

Plot No.	Fertilized annually. 600 lbs. per acre. 1931–1939	Representative Av. increase in yield over unfertilized plot (1-6-12) — Potatoes Av. 9 Yrs. (1931–1939) Bu. per acre	Conclusions from plot yields of various crops	Plot No.	Fertilized annually. 1000 lbs. per acre. 1931–1939	Representative Av. increase in yield over unfertilized plots (1-6-12) — Onions** Av. 8 yrs. (1932–1939) Bu. per acre	Conclusions from plot yields of various crops
1–6–12	0–0–0	...	For most general crops, the 1 to 3 phosphate-potash ratio gives best results but, in some cases, a 1 to 4 or a 1 to 5 ratio would be more economical.	1–6–12	0–0–0	...	On most mucks, the fertilizer need varies with various vegetable crops from a 1 to 2 to a 1 to 4 ratio of phosphate to potash.
2	0–0–32	128		2	0–0–24	141	
3	0–4–32	222		3	0–4–24	456	
4–7	0–8–32	258		4–8	0–8–24	509	
5	0–12–32	247		5	0–12–24	518	
8	0–8–24	242		7	0–8–32	502	
9	0–8–16	186		9	0–8–16	554	
10	0–8–8	91		10	0–8–8	501	
11	0–8–0	−13		11	0–8–0	52	

* Tables 2, 3, 4, and 6 taken from a new bulletin, "The Muck Soils of Michigan," soon to be published.

** The stand of onions on these plots was almost entirely destroyed by maggots in 1937, so that the average yield for the eight years was somewhat reduced by it.

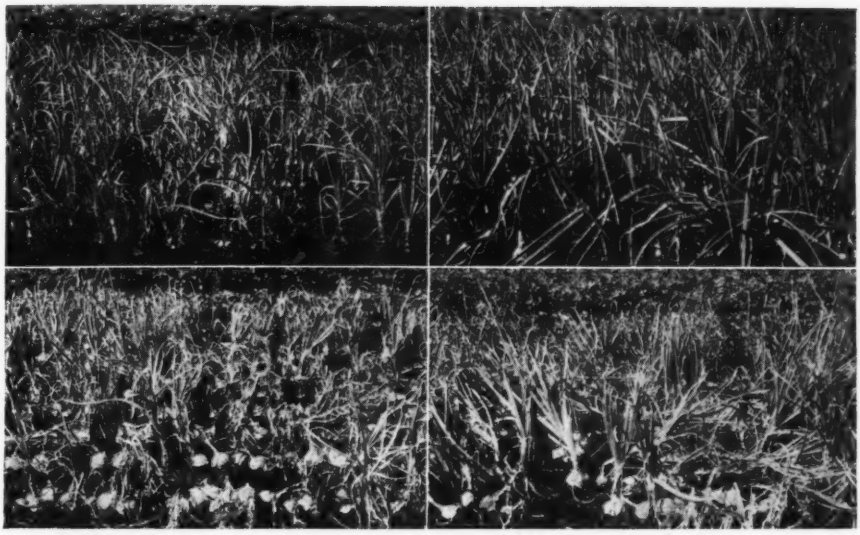


Fig. 2. Showing the effect of fertilization on yield and maturity of onions. Crop fertilized at rate of 1,000 pounds per acre of: Upper left, 0-8-0; lower left 0-8-16; upper right 0-0-24; lower right 0-8-24. Neither phosphate alone, with its stunted growth, or potash alone, with its excessive growth of tops, gave as good maturity as did a phosphate-potash mixture. The 0-8-16 gave the best maturity and yield.

to four per cent of total nitrogen which gradually becomes available as the muck decomposes after it is drained, most crops on properly drained new muck are well supplied with nitrogen from the soil itself. As the soil grows older and the rate of decomposition of the soil becomes less and less, a nitrogen hunger may gradually develop in the case of certain crops grown. The poorer the drainage is in a muck, the slower the decomposition will proceed and the greater will be the need for nitrogen, applied either in the regular fertilization, or, with some crops, as a side-dressing during growth. On the very strongly acid, but limed mucks, the decomposition will be limited to the relatively thin, limed surface layer, so that nitrogen will be required in

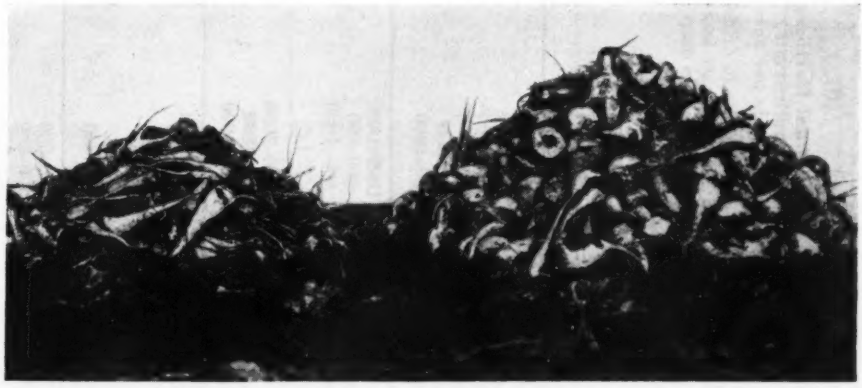


Fig. 3. The sugar beets on the left received 500 pounds per acre of salt, while those on the right received both salt and 600 pounds of 0-8-24. The average yield of beets was increased by the fertilizer 2.4 to 12.6 tons per acre.

TABLE 3.—FERTILIZER RECOMMENDATIONS FOR MUCK SOILS [5]

(A) Crop. When two fertilizer analyses are given, the first is generally preferred. Read footnotes very carefully.	(B) Annual fertilizer application Pounds per acre (Preferably in drills 7 inches apart and 3 to 4 inches deep).	TYPE OF MUCK			
		High-Lime (Deep or medium depth) Properly drained, pH range 7.0–4.6		**High-Lime**	**Low-Lime** pH 4.5 or less
		(C) Newly reclaimed (1–8 years), somewhat fibrous or woody. Heaviest fertilizer recommendation advisable for first few years after reclamation.	(D) Old muck (Well decomposed). If well fertilized in past years, applications can be reduced to the lowest recommendations.	(E) Poorly drained muck, Alkaline muck or Shallow muck.	(F) Very strangely acid muck (Limestone, marl, sugar beet lime or wood ashes required before fertilization).
Broccoli	400-600	0-8-24 or 2-8-16	3-9-18 or 0-8-24	3-9-18 or 3-12-12	3-9-18
Cabbage [2 3]	500-1000	Apply fertilizer (7-inch drills) before planting. For cabbage and cauliflower, transplanted to field, 400 to 500 pounds per acre can be applied in row 4 inches deep if muck is well supplied with moisture. Side-dressing of available nitrogen fertilizer (75 to 100 pounds) sometimes advisable, especially for cauliflower. These crops responsive to manure, supplemented with 0–8–24 mixture.			
Cauliflower [2]	800-1500				
Lettuce [1 2]	500-1000				
Spinach [1 2 4]	500-800				
Swiss chard [3 4]	500-1000				
Celery, early [1 3 4]	1000-1800	3-9-18 or 3-12-12	3-9-18 or 3-12-12	3-12-12	3-9-18
Radishes, early [1 2 3 4]	400-800	Row application for beets and celery advisable on wet muck—500 pounds 3 inches below surface. Apply remainder in 7-inch drills or broadcast and disk in. If no manure has been applied for celery, side-dressing of available nitrogen in fertilizer is beneficial, especially in cool seasons and on wet muck. If manure has been applied, nitrogen generally can be omitted from the fertilizer mixture.			
Table beets, early [1 2 3 4]	600-1000				
Celery, late [1 3 4]	1200-2000				
Radishes, summer [1 2 3 4]	400-800				
Table beets, late [1 2 3 4]	600-1000	0-8-24	0-8-24	3-9-18 or 2-8-16	3-9-18
Onions [1 2]	800-1200	Row application 400 to 500 pounds 2 inches below seed advisable on moist muck. Apply remainder in 7-inch drills. Try 0–20–20 or 3–12–12 if crop tends to mature late.			
		0-10-20 or 0-20-20	2-8-16 or 0-10-20	3-9-18 or 3-12-12	3-9-18
Mint [2]	200-400	Fertilizer needed to maintain stand of mint, as well as to increase oil content. Apply broadcast fairly early in spring. Try 0–20–20 if mint is late in blossoming.			
Beans [1 2]	250-500	0-10-20 or 0-8-24	0-8-24	0-10-20	0-10-20
Cucumbers and Melons	400-800				
Pumpkins and Squash	300-600	These crops easily killed by frost, therefore generally not safe on muck soil. Keep soil compact and well supplied with moisture to help prevent frost injury.			
Tomatoes [2]	500-1000				

Barley (With or without seeding)[1 2]	**250-400**	To secure satisfactory results from fertilizers, grow grain varieties adapted to muck land, such as Gopher oats, Peatland barley and Rosen rye.			
Oats (With or without seeding)[1 2]	**250-400**				
Rye (With or without seeding)[1 2]	**200-350**	**0-8-24 or 0-8-32**	**0-8-32 or 0-8-24**	**0-8-24 or 0-10-20**	**3-9-18 or 0-8-24**
Mangels[3 4]	**300-500**	Row application advisable for sugar beets, not more than 150 pounds per acre with seed, or not more than 300 pounds 2 to 3 inches below seed. Apply remainder in 7-inch drills 4 inches deep before planting.			
Sugar beets[2 3 4]	**300-600**				
Kohlrabi & Kale[3]	**500-600**				
Field corn[1 4]	**250-350**	If row application is made for corn, do not use more than 200 pounds per acre for field corn and 400 pounds for sweet corn, preferably at least 2 inches below seed.			
Sweet corn[1 4]	**400-800**				
Sunflowers	**250-400**				
Potatoes[1 2]	**600-1000**	Row application sometimes advisable for potatoes but not more than 400 pounds per acre preferably in furrow 2 to 4 inches below seed. If mixed with muck with machine planter, 600 pounds can be safely applied. Plant close to avoid hollow heart and to minimize frost danger.			
Permanent pasture	**75-150**	Apply fertilizer broadcast on pasture in spring. Growth increased and palatability and nutritive value of grass much improved by proper fertilization.			
Timothy and Alsike	**200-350**				
Sweet Clover	**200-350**				
Reed Canary Grass	**300-400**	Seeding hay without nurse crop often advisable. Early seeding necessary to beat weed growth.			
Hungarian Millet[1 2]	**200-300**				
Soybeans[1]	**200-350**				
Sudan grass[1 2]	**200-300**	**0-8-32 or 0-8-24**	**0-8-32**	**0-8-24**	**3-9-18 or 0-8-24**
Asparagus	**400-800**				
Parsnips	**600-1000**				
Rutabagas and Turnips[3]	**300-500**	For root crops, apply with fertilizer drill, or broadcast and disk in before seeding.			
Stock Carrots	**300-500**				
Table Carrots[2]	**400-800**				
Blueberries[2]	**500-800**	Blueberries require very strongly acid soil. On slightly acid muck, crop can be improved by application of 1000 to 3000 pounds of sulphur per acre. Crop not recommended on mucks of high pH.			
		0-8-24	**0-8-24**	**0-8-24**	**3-9-18**
Raspberries[1 2]	**500-800**	Raspberries adapted to acid mucks. Light applications of sulphur sometimes beneficial.			
Strawberries[1 2]	**200-600**	For berry production on strawberries, use 100 to 200 pounds fertilizer per acre; for plant production, apply 500 to 600 pounds.			

[1] These crops likely to show marked response to sulphur or manganese sulphate when grown on alkaline muck.
[2] These crops very likely to respond to copper sulphate when grown on acid muck (pH 6.0 or less).
[3] These crops are likely to respond to salt in fertilizer mixture.
[4] These crops occasionally benefited by light application of borax, especially on previously unfertilized muck.
[5] Fertilizer mixtures having the same ratios as those recommended, but of higher or lower analysis, would be equally desirable, a proportionately smaller or larger amount per acre being needed by the crop.

Fig. 4. Showing the effects of potash in improving the stand as well as the yield of the summer spinach crop. From front to rear these plots received 1,000 pounds per acre of the following mixtures: 0-8-0, 0-8-8, 0-8-16, 0-8-24, 0-8-32 and, in the vacant space well down in the field, no fertilizer. Note the effects of potash on stand as well as on growth.

the fertilizer mixture for several years, or until the applied lime has had time to correct the intense acidity for some distance below the surface.

Crops most likely to be benefited by the use of nitrogen include cauliflower, celery, lettuce, and Swiss chard. Cabbage, mint, onions, spinach, and sometimes radishes and table beets also will respond if the crop is sown in early spring, or if the drainage is poor or the muck old and well decomposed. Side-dressing of a nitrogenous fertilizer, such as nitrate of soda or sulphate of ammonia, applied during growth, if the cabbage, celery, cauliflower, lettuce, spinach and, occasionally onions, do not have good color, generally will produce increased yields.

The Soil Reaction. Another factor which has been given much consideration in the management of our mucks in recent years is that of the soil reaction. Experiments have definitely proved that the yields of most crops are likely to be very poor when the pH of the muck is below 4.6. Further, we find in a majority of mucks that the soil pH decreases from the surface downward. Thus a plowed layer with a pH of 5.0 occasionally overlies a second foot with a pH as low as 3.5 to 4.0. For that reason a soil test of the muck at a depth of 20 to 24 inches, along with one in the plowed layer, is always advisable. Wherever the soil test is below a pH of 5.0, even though the crop is yielding satisfactorily, it is advisable to make an application of one to three tons per acre of a liming material every few years and to watch the reaction, since the supply of lime in a soil of that reaction is rather limited. With a certain amount removed each year in a good crop yield, the time is likely to come when the crop will suffer. With a pH of 4.0, from three to five tons per acre of limestone or six to ten loads of marl will probably be required. Since an excessive application of a liming material may result in depressed yields of most muck crops, it is advisable not to overdo the liming. An application of 100 pounds per acre of manganese sulphate in the fertilizer mixture used immediately after liming will insure the crop against any possible depressing effect of the lime.

(*Continued next month*)

Soil and Plant-tissue Tests as Aids in Determining Fertilizer Needs

(*From page* 11)

TABLE 1. SOIL AND TISSUE TESTS OF A NITROGEN-STARVED SOYBEAN FIELD

Factor	Area A Near road		Area B Away from road	
	Soil tests	Tissue tests	Soil tests	Tissue tests
pH	6.3	.....	5.3	.....
Nitrate	Very low	None*	Very low	None*
Phosphate	" "	High	" "	Very high
Potash	" "	None	" "	Medium
Inoculation (nodule growth)	Fair	.....	Very poor	.....

* Nitrate nitrogen tests are of no significance in the case of legume plants because the nitrogen is present in organic forms not indicated by the nitrate test.

although the soil tests showed "very low" for phosphate and for potash. Here the conclusion was that the plants were starving for nitrogen because of a too strongly acid soil. The order of limiting factors was acidity, nitrogen, potash, and phosphate.

Case 2.—Diagnosis of the causes for failure in a white clover bluegrass pasture, Lafayette, Indiana, May 18, 1938.

This was a poorly growing pasture on a Crosby silt loam soil. The results of the soil and tissue tests are shown in Table 2.

2. The phosphate and potash were accumulating in the tissues of the grass because the grass was not able to grow for a lack of the first limiting factor, nitrogen, with the result that the phosphate and potash were not utilized in the plant synthesis. Note that the phosphate and potash tissue tests were high and medium, respectively, while the soil tests indicated a very low availability of these nutrients.

3. The white clover showed a good color, indicating that it was able to obtain its necessary nitrogen, but failed

TABLE 2. SOIL AND TISSUE TESTS OF A POOR GRASS AND LEGUME PASTURE

Factor	Soil tests	Bluegrass Tissue tests	White clover Tissue tests
pH	5.6	.....	.....
Nitrate	Very low	None	None (no nitrogen starvation symptoms)
Phosphate	" "	High	None
Potash	" "	Medium	None

Interpretations of tests in Case 2.

1. Nitrogen was the first limiting factor in the growth of the bluegrass. The leaves verified this by their pale, greenish color.

to grow well because of the very low available supply of both phosphate and potash.

Case 3.—Diagnosis of a golf green that was showing a browning condition

in the leaf tips during late July and early August, Highland Park Country Club, Indianapolis, Indiana, August 10, 1939.

This was typical of many golf greens of the late summer season where a general browning of the grass leaves was occurring on the greens. Complete fertilizers had been added in the spring with bi-weekly treatments of ammonium sulfate throughout the summer. The results of the tests are shown in Table 3.

TABLE 3. SOIL AND TISSUE TESTS OF A GOLF GREEN

Factor	Soil tests	Grass tissue tests
pH	6.8	
Nitrate	Very high	Very high
Phosphate	" "	" "
Potash	" "	None

Interpretation of tests in Case 3.

1. The soil tests showed "very high" in nitrates, phosphate, and potash, with a satisfactory pH. However, since the arsenic treatments of the soil would interfere with the phosphate test and make it read "high," and the ammonia ion from the ammonium sulfate used weekly would interfere with the potash test and give it too high a reading, the soil tests became useless. Here the tissue tests were invaluable, for they showed the grass to be starving for the lack of potash. When potash was supplied the grass revived to make normal growth. The frequent use of a salt like the ammonium sulfate, along with much leaching from heavy watering, had probably caused the potash to be removed from the soil, and developed an unexpected deficiency in this element, even though it had been liberally applied earlier in the season.

Cases 4 and 5—Tissue tests with corn.

A great many tissue tests have been made on the corn plant. This is one of the most indicative crops to study because corn has such a wide distribution in the world and can be used as a fair guide as to what to expect from many other crops. The two cases presented are very typical as to relationship between the tissue tests, the soil fertility, and the yields of corn obtained. The possible interpretations are discussed.

Case 4. (Data by Harry L. Cook, Purdue University, 1939.) The soil was a Clermont silt loam, low in organic matter content, strongly acid, pH 4.9, and showed "very low" in available phosphate and potash by soil tests.

Interpretations of tests in Case 4.

1. Where no nitrogen was used or only 21.5 pounds of nitrogen had been added to the corn, plots 1, 2, 5, and 6 were handicapped as early as June 7 for the lack of nitrogen. By July 7, plots 1 and 2 were showing marked injury for the lack of nitrogen.

2. By August 14, the corn on plot 4 was suffering for the lack of nitrogen even though 86 pounds of nitrogen per acre had been applied. Here the growth was great enough to cause a demand for potash greater than the soil could supply, even with the 12 pounds of K_2O that had been added in the row. The test showed that potash was limiting the growth here to a greater extent than was the nitrogen.

3. The plants started to be deficient in potash by July 7 where the nitrogen fertilization was the greatest but where no extra potash had been used, plot 4. Note that here the corn yield was only 55 bushels per acre. Plot 8 received an equal amount of nitrogen, but with 100 pounds of muriate of potash extra the yield went to 64 bushels of corn per acre.

4. It is apparent from the tests that the yield from plot 8 was limited by a shortage of nitrogen. This was verified

TABLE 4. TISSUE TESTS OF CORN AS RELATED TO FERTILIZATION AND CORN YIELDS. PLANTED MAY 17, 1940

Plot No.	Lb. cyanamid added per acre*	Lb. extra K_2O added per acre†	Yield bu. corn per acre	Plant-tissue tests and dates made		
				June 7	July 7	Aug. 14
1	0	0	27	L-H-H‡	O-H-H	O-H-H
2	100	0	37	L-H-H	L-H-H	O-H-H
3	200	0	45	H-H-H	H-H-H	O-H-M
4	400	0	55	H-H-H	H-H-M	L-H-O
5	0	50	26	L-H-H	O-H-H	O-H-H
6	100	50	36	L-H-H	L-H-H	O-H-H
7	200	50	47	H-H-H	H-H-H	O-H-H
8	400	50	64	H-H-H	H-H-H	L-H-H

* The cyanamid (21.5% N) was broadcast and plowed under just before planting time.
† All of the plots received 300 lb. per acre of 0-16-4 fertilizer in the drill at planting time; the extra potash was added as muriate of potash and plowed under like the cyanamid.
‡ O = none, L = low, M = medium (doubtful), H = high for the tissue tests. The positional order of the letters is nitrates, phosphate, and potash. Thus the first letter represents the test for nitrates; the second letter, inorganic phosphate; the third letter, potassium.

by other plots the same year on this soil where 118 pounds of N, along with 72 pounds of P_2O_5, and 72 pounds of K_2O produced 72 bushels of corn per acre.

Case 5. (Data by Alvin J. Ohlrogge, Purdue University, 1939.) The soil was a Vigo silt loam, gray in color, showed "very low" in available phosphate and potash by soil tests, and had a pH of 5.0.

Interpretations of tests in Case 5.

1. The tests on May 22 were made only nine days after the corn was planted. Where no fertilizer was used the plants were short of phosphate, but where the phosphate was supplied in the 0-12-12 the first limiting factor became nitrogen. The purplish color of the young corn plants on plot 1 was associated with the shortage of phos-

TABLE 5. TISSUE TESTS OF CORN AS RELATED TO FERTILIZATION AND CORN YIELDS. PLANTED MAY 13, 1940

Plot No.	Lb. ammonium sulfate added per acre*	Mixed fertilizer added at planting at side of seed in row†	Yields per acre		Plant-tissue tests and dates made		
			Bu. ear	Lb. stover	May 22	July 9	July 17
1	0	0	29	1140	H-L-M‡	O-H-H	O-M-H
2	0	0–12–12	26	1310	O-H-H	O-H-H	O-H-M
3	0	3–12–12	31	2660	M-H-H	O-H-H	O-H-M
4	200	3–12–12	63	3450	H-H-H	L-H-H	H-H-M
5	400	3–12–12	82	3830	H-H-H	M-H-H	H-H-L

* The ammonium sulfate (20.5% N) was broadcast and plowed under just before planting time.
† The fertilizers were added at the rate of 600 lb. per acre, in the drill at the side of the seed.
‡ O = none, L = low, M = medium (doubtful), H = high for the tissue tests. The positional order of the letters is nitrates, phosphate, and potash. Thus the first letter represents the test for nitrates; the second letter, inorganic phosphate; the third letter, potassium.

phate, and the pale green color of the plants on plot 2 was associated with a shortage of nitrogen. In plot 3 where 600 pounds of 3-12-12 had been used, the 18 pounds of N in the fertilizer should have been more than enough for the corn at this early growth, but the balances of nitrogen with the other nutrients were apparently unfavorable.

2. By July 17 nitrogen had become a first limiting factor on all of the plots except where ammonium sulfate had been plowed under. On plots 4 and 5 it appeared that the plants were limited in their performance for potash, even though 72 pounds of K_2O per acre had been applied. Note that when the tests showed "medium" and "low" where 200 and 400 pounds of ammonium sulfate had been used, plots 4 and 5, the nitrate tests showed "high." Apparently, the yields would have been still greater if the potash supply had been adequate here. Perhaps sufficient pounds of potash may have been used and the roots were unable to absorb enough of it out of the dry upper soil; at any rate the plants indicated that not enough potash was being absorbed.

3. In comparing the performance of plots 3 and 4, it is noted that 31 bushels of corn were produced with the 18 pounds of nitrogen added to plot 3, and 63 bushels of corn were produced on plot 4 which received 41 pounds more nitrogen than plot 3. Here the 41 pounds of nitrogen on plot 4 produced an increase of 32 bushels of corn over that of plot 3. Thus, one bushel of corn was produced per 1.2 pounds of added nitrogen. On nitrogen-deficient soils where the phosphate and potash supply is lower than on plot 3, a corn increase of one bushel for each 2 pounds of added nitrogen is the usual performance. Note that the stover growth was fairly good on plot 3, yet the nitrate tests were "low" from July 9 on. Apparently the fertilizers used in plot 3 were just about enough to produce a fairly good stalk, but the supply of nitrogen ran out just at the critical time when the ears were to be formed. When the extra nitrogen was applied it supplied the final "push" to produce the ears. Without the use of the tissue tests these types of informative studies would be impossible.

Conclusion. Soil tests have many limitations that need to be considered in evaluating their results. If these limitations are considered, these tests

Plants in the field show nutrient-deficiency symptoms, easily read by those who understand them.

are in many cases helpful in obtaining ideas about the state of the soil fertility. However, plant-tissue tests present a technique that appears to lend itself to very reliable interpretation of the nutritional situation.

Since crop production is a dynamic process that requires constant study as to the fertility of the soil, it should be of advantage to a grower to study the performance of the growing crop with tissue tests. The results will furnish information on the status of the nutrient supply of the plants at any time during the growing season, and if these results are associated with the treatments used to produce them, will give corrective information to incorporate into fertilization practices for the next crops on that soil.

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Bovinology

(*From page* 5)

That's a warning for my fellow citizens in the dense dairy areas, for the percentage of farmers in such states who really know whether their herds are going forward or backward is pitifully small. Even the goat raisers have the edge on them.

Left to fate and their own inertia, those behind-handers are cheerful victims of a rather new sort of racket which has been a nightmare to the purebred devotees. I refer to the all-enticing glamor of having somebody hand you a bull for nothing. Free-for-nothing and good-for-less bulls have dotted the landscape in my countryside at an alarming rate since the original bull prophets enlisted in the aforesaid federal forces. These bull-givers waste no time on catalogs or advertising, but they merely drive in and dump a specimen off the tail-end of the truck and pass on. Your farm is just a training ground for the stockyards to them.

When one looks a gift horse in the mouth it's supposed to be a slam at the giver. But it's wise to look a gift bull in the mouth and lots of other places, including his pedigree papers, the place he hails from and also his progeny.

Hustling any old kind of a male bovine around the community just to get cows in the family way is a slick deal for somebody. But any farmer

who uses a scrub sire on a fairly good grade herd is just looking for one biological result—a fresh cow. And the offspring will be nondescript.

Like begets like. The farmer who doesn't have any idea of adding to the beauty of his herd or making it any more economical to keep is the one who beckons to the butcher with one hand and invites the bull jockey to trot in another one of his slanty-rumped rats.

Sometimes you meet a man who says he won't raise any heifers in his own herd, but will buy up good cows and then freshen them with some handy maverick leased from a jockey. That fellow must sell on a mighty high fluid milk market, maintain a good sized wad of jack in his sock to gamble with, or possess more courage than brains. The ones who raise their own kine last longer in a pinch, and maybe we're going to have another pinch sooner or later.

The other excuse given by patrons of the mongrel bull merchants is that he "intends to cross-breed dairy cows with some masculine meat-making male of beef calibre." Oh, yes, it's easy enough to mix them, but the "unmixing" is tough, and the result is neither veal, beef, nor beauty.

WHEN this "free-bull-and-use-him-awhile" plan plays havoc with customary standard methods of improving herds, the leaders of dairy advancement must meet it with similar systems. Getting strong, bred-for-production, high type bulls into isolated rural districts is a real job of organization. Unless they expect to depend upon artificial insemination to grade up and improve production, the breeders with promising bulls must study ways to make their cattle just as attractive as the deals put over by sellers of culls. Lately there is evidence that something is going to happen along this line, even if it sounds like a dollar down and a dollar a week to get it started.

Yet maybe it required just such a dangerous threat to awaken the indolent breeders into a fighting spirit. Like the old hound dawg with pesky fleas, it keeps him lively and alert so he won't fall asleep and have bad dreams.

Speaking of bad dreams, have you ever thought what would happen to the milk price if we doubled or trebled our converts to the use of bulls capable of higher levels of production in their herds? No great fret thereabouts for the immediate present, perhaps, but it's tossed in to show the economists that we know their stuff.

And finally, when we sit back and get a squint-eyed perspective on this better bull campaign dope, I wonder if you see what I see.

TAKE for example a meeting of leaders in a milky community, bending every effort to increase the number of other farmers with better bulls and more productive cows. Where do you find merchants or professional men conspiring to cause a denser population of competing grocers or clothiers or dentists or lawyers? My home state sent several extension trains to Dixie years go and for awhile our farmers sold breeding stock southward. But later there was a slowing up of that income and now they are bothered about the fears of an excess expansion of dairying below the frost belt.

Maybe the careful and successful breeder is so scarce he is lonesome and he may be tired of being a target for envy. Perhaps he wants company to share the misery coming in the wake of the anticipated lactic overflow. At any rate, you can't call him mean or narrow for spending his time boosting for better bulls when he might just as well stick to his own stanchions and benefit by a scarcity of proven bovines.

But thank our stars, the good farmer wants to improve everything he touches. That's the answer. More power to him! Even if he is a mighty small piece of leaven (of energy) in a whopping big loaf (of inertia) he is bound in time to make it rise, and then we won't go hungry!

ENOUGH IS ENOUGH

Elmer, age 13, was puzzled over the girl problem and discussed it with his pal, Joe.

"I've walked to school with her three times," he told Joe, "and carried her books. I bought her ice-cream sodas twice. Now do you think I ought to kiss her?"

"Naw, you don't need to," Joe decided, after a moment of deep thought. "You've done enough for that girl already."

Two dignitaries of the church and a layman were golfing one day recently. One rector made a particularly bad shot and the layman asked: "Don't you feel like swearing when that happens?" . . . And the rector replied with heat: "I don't swear, but I spit—and where I spit no grass ever grows."

Johnny had seen his mother measure a yard by holding one end to her nose and the other at arm's length. One day he came running in with a piece of rope.

"Here, mother," he said, "smell this and see how long it is."

Boy Friend (on the phone) "Whatcha doin' Sattidy night?"

"Gotta date."

"An' next Sattidy night?"

"Gotta date."

"Anna next Sattidy night?"

"Gotta date."

"Well twiddle my moustache, woman, doncha ever take a bath?"

"If there be anyone in the congregation who likes sin let him stand up—what's this, Sister Virginia, you like sin?"

"Oh, pardon me, I thought you said gin."

Old Rastus settled himself in his chair and addressed his wife: "Yes, sah, Gal, dat boss done cut wages half in two again. Some ob de boys is kickin' might pow'ful 'bout it. But I ain't goin' to kick none. Way I figgers it—half of sumpin' is better'n all of nuffin'."

OKE, MONSIEUR

"Consommé, bouillon, hors d'oeuvres, fricassee poulet, pommes de terre au gratin, demitasse des glaces, and tell that mug in the corner to keep his lamps offa me moll, see?"

"Now that I've told you about my past, do you want to marry me?"

"Sure, baby."

"I suppose you'll expect me to live it down?"

"No! I'll expect you to live up to it."

The young author wrote asking an editor for his definition of the perfect short story.

The editor replied that it must be (1) short and to the point; (2) contain a religious touch; (3) have some reference to the aristocracy; (4) have action; (5) possess sex appeal.

Whereupon the author sent along the following:—

"Good Heavens!" said the Duchess, "you're pulling my leg."

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